87-2048

No.

Supreme Court, U.S.
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IN THE

Supreme Court of the United States

OCTOBER TERM, 1987

UNIROYAL, INC.,

Petitioner,

—v.—

RUDKIN-WILEY CORPORATION,

Respondent.

PREMIX, INC.,

Petitioner,

—v.—

RUDKIN-WILEY CORPORATION,

Respondent.

PETITION FOR A WRIT OF CERTIORARI TO THE UNITED STATES COURT OF APPEALS FOR THE FEDERAL CIRCUIT

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Questions Presented

1. Whether a court of appeals can apply the appellate rules so as to impose upon an appellee a practical obligation to see that *all* evidence in the record that supports each factual finding of the district court is reproduced in the appendix to the court of appeals or suffer the peril that the court of appeals will, on the basis of a review of no more than the evidence reproduced in that appendix, reverse the judgment of the district court as based on insufficient evidence.

2. Whether the Federal Circuit, without reviewing the entire record which was before the district court or all of the evidence in that record which is pertinent to each of the following issues, can

(a) reject the district court's finding that it would have been obvious to one of ordinary skill in the art at the time of the invention to combine certain references; and then itself, without remand, make a contrary determination;

(b) conclude that the district court "erroneously analyzed and weighed secondary considerations"; and then itself analyze and weigh the partial evidence on same set forth in the appendix and, on its own, make findings in conflict with factual findings of the district court;

(c) set aside and reverse a factual finding of the district court that the accused deflector was "a fairing type device, instead of a baffle."

3. Whether the portions of the record included in the appendix to the Federal Circuit adequately supported findings by the district court as to (a) the existence within the prior art of a suggestion to combine references; (b) the absence of long-felt need for the patented device; and (c) the fact that the accused device was a fairing-type device rather than a baffle.

4. Whether the Federal Circuit was correct in interpreting the district court's opinion as finding "at least in some instances" literal infringement of claims 1 and 2.

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IN THE

Supreme Court of the United States

OCTOBER TERM, 1987

UNIROYAL, INC. and PREMIX, INC.,

Petitioners,

—v.—

RUDKIN-WILEY CORPORATION,

Respondent.

PETITION FOR A WRIT OF CERTIORARI TO THE UNITED STATES COURT OF APPEALS FOR THE FEDERAL CIRCUIT

Uniroyal, Inc. ("Uniroyal") and Premix, Inc. ("Premix") petition for a writ of certiorari to review that portion of the judgment of the United States Court of Appeals for the Federal Circuit that vacated and reversed the district court judgment holding patent invalidity and noninfringement.

OPINIONS BELOW

The opinion of the Court of Appeals for the Federal Circuit is reported at 837 F.2d 1044 and is set forth as Appendix A (1a-22a, *infra*). The opinion of the United States District Court for the District of Connecticut is unreported and is set forth as Appendix B (23a-54a, *infra*). The order of the Federal Circuit denying petitioners' petition for rehearing, which is unreported, is set forth as Appendix C (55a-56a, *infra*). The order of the Federal Circuit declining petitioners' suggestion for rehearing in banc, which is unreported, is set forth as Appendix D (57a-58a, *infra*).

JURISDICTION

The opinion of the Court of Appeals for the Federal Circuit was rendered on January 13, 1988. Uniroyal and Premix filed a timely petition for rehearing and suggestion for rehearing in banc. The petition for rehearing was denied by the Federal Circuit on March 31, 1988, and the suggestion for rehearing in banc was declined on May 10, 1988. The jurisdiction of this Court is invoked under 28 U.S.C. § 1254(1).

CONSTITUTIONAL PROVISIONS AND STATUTES INVOLVED

Constitution of the United States, article I, section 8, clause 8:

> The Congress shall have power . . . To promote the progress of science and useful arts, by securing for limited times to authors and inventors the exclusive right to their respective writings and discoveries.

Also involved, 35 U.S.C. § 103 (1982 and Supp. III 1986), Rules 10(a), 10(b), 10(d), 10(e), 11(e), 30(a) and 30(b) of the Federal Rules of Appellate Procedure, Rules 11(a)(1) and 11(a)(4) of the Rules of the United States Court of Appeals for the Federal Circuit and Rule 52(a) of the Federal Rules of Civil Procedure. These provisions are set forth as Appendix H (86a-91a, *infra*).

STATEMENT OF THE CASE

INTRODUCTION

A tractor-trailer vehicle travelling at high speed encounters resistance to forward movement when the blunt face of the trailer, which is usually higher than the tractor, is exposed to the oncoming wind. Aerodynamic forces coming in contact with such a bluff body result in air turbulence and a rearward directed pressure against the exposed portion of the trailer.

These forces, described as an aerodynamic drag ("drag"), hinder the truck's forward movement. (Appendix B at 24a, *infra.*)

United States Patent No. 3,241,876, (the " '876 patent"), the patent in suit, was issued March 22, 1966 to Walter Selden Saunders ("Saunders") and covered an airflow deflecting baffle that is attached to the roof of the tractor cab for diverting the oncoming airflow away from the face of the trailer. (Appendix J, col. 1.) Among the stated objects of the invention was the reduction of fuel consumption by reducing the resistance due to drag in a manner different from prior streamlining devices. (Appendix J, col. 1 at lines 32-37.)

According to the '876 patent, prior conventional streamlining techniques had attempted to minimize the forward separation of the air stream flowing over the frontal contours of a moving tractor-trailer combination by rounding the forward corners of the truck, adding streamlining vanes or guide vanes to keep the air separation to a minimum, or enclosing the gap between the tractor and trailer with some form of fairing. (Appendix J, col. 1 at lines 59-66.) The '876 patent further stated that the instant invention differed from the above in that it employed a deflecting device mounted on the roof of the tractor in such a manner as to occasion a very large separation of air flow; and that this deflection was made to occur in such fashion that the flow moved convexly across the gap between the tractor and trailer and re-attached to the forward periphery of the trailer. (Appendix J, col. 1, at lines 66-72.)

Claims 1 and 2 of the '876 patent defined the invention as comprising an airflow deflecting baffle[1] used in combination with a tractor-trailer vehicle, wherein the baffle is mounted to extend above the tractor cab roof and is vertically inclined rearwardly and forwardly convexed in a horizontal plane; such baffle is to have a height substantially 0.7 of the difference in height between the cab roof and the trailer roof and is to be positioned a distance from the front of the trailer approximately

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1 Claim 2 describes the device as "an air flow deflecting shield comprising a baffle. . . ." The full text of claims 1 through 4 is set forth at Appendix A at 21a-22a, *infra.*

0.7 the half width of the trailer. Claims 3 and 4 cover a substantially solid upstanding air flow deflecting baffle having its lower edge in substantially air impervious relationship with the cab roof, and specify a range of height and distance parameters rather than the 0.7 ratio contained in claims 1 and 2. (Appendix J at col. 8.) Various other structural and functional limitations are found in some of these claims and not in others.

In the mid-1960's, respondent Rudkin-Wiley under license from Saunders designed and built, "based on the tenets of [the '876] patent," deflectors sized to be 0.7 the differential height between cab roof and trailer roof. (Appendix B at 23a, 39a, *infra*; Appendix E at 68a, *infra*.) Despite early marketing efforts, however, not until 1974—after the oil crisis of late 1973 had occurred—did Rudkin-Wiley's sales of its deflectors begin to reach significant levels. (Appendix B at 40a, *infra*.) At that time, other manufacturers entered the market with various add-on devices to reduce fuel consumption for tractor-trailers by reducing drag. (Appendix E at 59a-60a; 69a-71a, *infra*.) In 1974, Robert Dorsch was commissioned by Uniroyal to design a drag reducing device (Appendix B at 49a, *infra*.), and, by late that year, had designed a production model of same. (Appendix E at 59a-60a, *infra*.) In February of 1975, Uniroyal commenced Civil Action No. 75-51 against Rudkin-Wiley seeking a declaration that the '876 patent be declared invalid, unenforceable and not infringed. A similar suit by Premix was filed in 1980.[2] Rudkin-Wiley filed counterclaims for infringement in both cases.

THE TRIAL

The district court heard the consolidated cases in a bench trial that included eight full weeks of testimony. Over the course of that time, the district court: observed, and heard explanatory testimony concerning, videotaped aerodynamic experiments carried out by both sides showing air flow patterns of commer-

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2 The companion action by petitioner Premix, Inc. (B-80-281) was commenced on June 2, 1980, just after Premix acquired Uniroyal's air deflector business. References hereinafter to Uniroyal shall be deemed to include Premix.

cial embodiments of both the Saunders and Uniroyal devices; heard 15 days of testimony from aerodynamic experts, including in-court experiments and preparation in court at an easel of sketches, formulae and calculations—all designed to familiarize the district court with the relevant principles of aerodynamics and fluid mechanics with which a person of ordinary skill in the art at the time the invention of the '876 patent was made would have been familiar; heard in the course of seven days of testimony from Rudkin-Wiley's president, how, over the years, Rudkin-Wiley had changed the shape of its deflectors significantly (Appendix B at 49a n.5, *infra*); and heard detailed testimony from Robert Dorsch as to how he had gone about designing and developing the Uniroyal deflector. (Appendix B at 44a, 49a, *infra*.)

On the basis of the complete record before it, the district court made the detailed factual inquiries and findings required by *Graham v. John Deere Co.*, 383 U.S. 1, 17 (1966). From its study of the evidence, the district court analyzed in detail both the scope and content of the prior art and the differences between the prior art and the claims at issue. (Appendix B at 31a-38a, *infra*.) The district court also found that the level of skill which a person of ordinary skill in the pertinent art at the time of the invention would possess would be that of an engineer familiar with aerodynamic or fluid mechanic principles. (*Id.* at 39a.) Finding that a person of ordinary skill at the time the invention was made would have looked toward aerodynamic or fluid mechanic solutions to the problem faced by objects having to move through and resist fluid, the district court further found that a significant number of references were well within the realm of such prior art. (*Id.* at 31a-38a.)

Among these references were reports concerning wind-tunnel experiments conducted at the University of Maryland under the sponsorship of a trailer manufacturer in the early 1950's. (Appendix B at 32a; Appendix E at 75a-76a, *infra*.) These studies had all involved utilization of conventional streamlining techniques, including testing of a smooth contoured surface, or fairing, placed over the entire gap between tractor and trailer. The district court found such a device would have been imprac-

tical "as long as attached to both tractor and trailer." (Appendix B at 41a, *infra.*) The 1953 report on said studies had suggested, however, that it might be reasonable to consider use of a fairing approaching the type tested which did not actually attach to the trailer. (Appendix E at 75a, *infra.*) Also included in the prior art so considered by the district court were books and articles, published prior to Saunders' invention, which discussed various aspects of the aerodynamic occurrences with which a person of ordinary skill in the art would have been familiar. (Appendix B at 34a, *infra.*)

The district court also found certain earlier patents to be pertinent art including, among others, (1) a 1958 patent issued to Stamm which disclosed streamlining devices consisting of conduits mounted to the roof of the tractor and to the top and sides of a trailer in a tractor-trailer combination wherein the airflow is directed from the top of the cab of the tractor over the gap between the back of the tractor and the front of the trailer to the top of the trailer (Appendix B at 32a-33a, *infra*; Appendix K); and (2) a 1913 Austrian patent issued to Constantin which, to make possible the building or improvement (without major rebuilding) of vehicles with large carrying capacity so as to reduce their resistance to motion in a fluid such as air, had provided for attachment at a suitable distance ahead of the vehicle, a shield of suitably shaped cross-section that is smaller than the front of the vehicle and that would deflect the layers of the medium which would otherwise have struck the vehicle and provided resistance to the motion. (Appendix B at 33a-34a, *infra*; Appendix L.)

The Constantin patent taught that the shield could be flat, or wedge-shaped, or in the shape of a shallow cone. (Appendix L at A107, figs. 1 and 2; Appendix E at 62a-65a, *infra.*) As an alternative to such a shield, Constantin taught that the deflecting device could be in the form of multiple curved sheets forming a structure the representation of which in the patent was remarkably similar to the conduits of Stamm. (Compare Appendix K, fig. 2 with Appendix L, figs 5 and 6.)

The district court analyzed the difference between the prior art and the claims at issue. It found that, as issued, the '876 patent differed aerodynamically from Stamm in that it used a widely deflecting shield instead of vanes to reduce drag; and it found that the vanes of Stamm made a small disturbance in the airflow by leading the air from an initial direction by means of a curvature, whereas the shields of the '876 patent, in the form essentially of a vertical flat plate or disc, made an abrupt change in the airflow. (Appendix B at 34a-35a, *infra*.)

The district court also found that the Constantin patent disclosed an alternative method to reduce drag for vehicles with large carrying capacities from the methods normally employed by streamlining devices. (Appendix B at 35a-36a, *infra*.) It found further that the Constantin patent shows that a flat-plated shield, if placed in front of a larger bluff body, will deflect the air stream away from the front of the bluff body thereby reducing the air resistance. (Appendix B at 36a, *infra*.)

After analyzing the differences between the Saunders patent and the Constantin patent, the district court found that both patents sought the same goal and that the differences between them were superficial. (Appendix B at 36a, *infra*.) The district court also analyzed the Saunders patent in light of prior art literature with which a person of ordinary skill in the art would have been familiar at the time of the invention (Appendix B at 37a-38a, *infra*); and it found in that literature, teachings and depictions analogous to the use of a deflecting baffle for a bluff body such as a tractor-trailer. (Appendix B at 38a, *infra*.)

In its analysis, the district court also considered evidence which had shown that, after Rudkin-Wiley had in 1966 acquired exclusive rights to the '876 patent, it had launched extensive promotional and sales efforts but had found that no real evidence of the trucking industry's receptiveness to the air deflector manifested for seven years. Then, in 1973, demand for a gas-saving device increased because of the oil crisis. Under these circumstances, the district court concluded that there was no evidence of a long-felt need for such a device and that, since there was no impetus to invent a gas-saving device until the 1973 gas

crisis, it was unknown whether others would have produced a similar device. (Appendix B at 39a-40a, *infra.*) The district court stated that it agreed with the conclusion of the Seventh Circuit in *Saunders v. Air-Flo Co.*, 646 F.2d 1201, 1208 (7th Cir. 1981) that because of these circumstances, "the commercial success is less likely to raise the inference that many skilled people had addressed the problem over time without finding the solution." (Appendix B at 40a, *infra.*)

The district court found that the '876 patent is a combination patent in that it combines teachings from more than one reference. (Appendix B at 40a, *infra.*) Analyzing the '876 patent in terms of the two-part standard inquiry outlined in *In re Sernaker*, 702 F.2d 989, 994 (Fed. Cir. 1983) for determining whether references are properly combined, the district court found (a) that the combination of the teachings of the prior art references would have suggested to one of ordinary skill in the art, the combining of such teachings along the line of the '876 patent (Appendix B at 41a, *infra*); and (b) that the features of the '876 patent did not achieve more than the combination of prior art references suggested. (Appendix B at 42a, *infra.*)

From all of the evidence, the district court concluded that Uniroyal had sustained its burden of showing by clear and convincing evidence that the '876 patent would have been obvious to an engineer with experience in aerodynamics and fluid mechanics at the time the '876 invention was made. The district court concluded that the differences between the prior art and the claims at issue were such that the subject matter of the '876 patent as a whole would have been obvious. (Appendix B at 43a-44a, *infra.*) The district court also made factual findings that Rudkin-Wiley had proven neither literal infringement nor infringement under the doctrine of equivalents. (Appendix B at 44a-52a, *infra.*)

THE APPEAL

A. *Validity*

Rudkin-Wiley appealed to the Court of Appeals for the Federal Circuit; and it filed a notice under Rule 10(b), Fed. R. App. P., that the complete transcript was on file with the district

court clerk. Under Fed. R. App. P. 10(a) and Fed. Cir. R. (11)(a)(1), therefore, the complete transcript and all of the exhibits were included within the appellate record.

As here pertinent, Rudkin-Wiley's notice under Fed. R. App. P. 30(b), accompanying its appendix designations, stated simply that Rudkin-Wiley would present for review "the validity of the Saunders patent under 35 U.S.C. § 103" and "infringement of the Saunders patent by Uniroyal and Premix." (Appendix G at 85a, *infra.*) By designation and counterdesignation, the parties thereafter identified for inclusion in the appendix to the Federal Circuit only about one-third of the non-damages testimony and a limited number of the trial exhibits, including fewer than half of the extensive number of prepared-in-court sketches and/or calculations by which the aerodynamic experts on both sides had explained their testimony to the district court.[3] Thus, a substantial portion of the non-damages evidence that formed part of the record on appeal as defined in Fed. R. App. P. 10(a) was not included in the appendix.

After noting that the factual findings underlying the obviousness determination made pursuant to *Graham* will be overturned on appeal only if they are clearly erroneous, the Federal Circuit analyzed the findings of the district court and the conclusions drawn from same. (837 F.2d at 1050, Appendix A at 7a-8a, *infra.*) The Federal Circuit found that the Constantin reference did not disclose a deflector having a convex shape or a rearward inclination. (837 F.2d at 1052, Appendix A at 9a, *infra.*) In light of its view that both the Maryland study and Stamm were based on the principle of streamlining, the antithesis of Constantin, "and the absence of any teaching or suggestion to combine these prior art devices," the Federal Circuit stated that "there is no apparent basis for the district court's

3 The following trial exhibits so prepared by the experts during their direct or cross-examination were not included in the appendix to the Federal Circuit: Pls.' Exhs. 370, 399, 403, 404, 407, 409, 410, 420, 421, 422, 423, 424, 425, 427, 431; Df's. Exhs. IC, IG, IH, JV, JW, JX, JY, JZ, KB, KC, KD, KG, KK, KM, KN, KU, KX, LM. For examples of analogous prepared-in-court explanatory sketches which *were* included in the appendix to the Federal Circuit, see Appendix N at A129-A130.

conclusion that it would have been obvious to one skilled in the art to make the combination." (837 F.2d at 1052, Appendix A at 11a, *infra*.) It concluded that the district court had reached its conclusion based on hindsight. (837 F.2d at 1054, Appendix A at 14a, *infra*.)

The Federal Circuit also reviewed the district court's findings on secondary considerations; and, although the district court had found that the features of the '876 patent did not carry with them a new unexpected result (Appendix B at 42a), the Federal Circuit itself found that the uniqueness of the '876 invention led to its success after the oil crisis. On its own analysis, the Federal Circuit stated that "we are convinced that the secondary evidence as a whole strongly suggests the nonobviousness of the invention."

The Court went on to state:

> Having carefully reviewed the record, we conclude that the district court impermissibly used a hindsight analysis in determining that the claimed invention would have been obvious and did not properly analyze and consider secondary indicia of nonobviousness. Accordingly, that portion of the judgment holding that the '876 patent is invalid is reversed. (837 F.2d at 1054, Appendix A at 14a, *infra*.)

B. *Infringement*

Among the issues sharply contested at trial was whether the Uniroyal device and the device of the '876 patent operated pursuant to the same or different principles. In a brief which Rudkin-Wiley had filed with the Seventh Circuit in *Saunders*, Rudkin-Wiley had described as two fundamentally different aerodynamic devices: (a) the Saunders baffle, a device "which obstructs rather than conducts flow," which operates by creating air separation and which is readily distinguishable from streamlining devices both in structure and manner of operation (Appendix E at 61a-62a, *infra*); and (b) a fairing, a streamlining device which operates by avoiding air separation and which performs its function "in a manner diametrically opposite to that of a baffle-type deflector." (*Id.*) In fact, the height and distance

formulae set forth in claims 1 and 2 of the '876 patent had been derived through an idealized experiment using a disc mounted to windward of a cylinder having a larger radius than the disc. (Appendix J, column 4, lines 9-45, figs. 8, 9.) In response to early Patent Office rejection, Saunders had stated that "[t]he air deflectors shown and described in the instant application are essentially flat plates attached to the tractor perpendicular to the direction of motion of the vehicle." (Appendix E at 77a *infra*.)

The district court had noted that claims 1 and 2 of the '876 patent disclosed an "airflow deflecting baffle"; and it had found the device of that patent to be essentially a flat plate, high-drag device that widely deflects the air flow away from a bluff body towards the face and up to the sides of a vehicle so as to reattach rearward of the front portion of the rectangular body. (Appendix B at 36a, 49a n.5, *infra*.) By contrast, the district court had found that the Uniroyal deflector was a streamlined, low-drag device shaped somewhat like a hemispheric shell with a smooth, curved forebody. (Appendix B at 49a, *infra*.) In its comparison of the Uniroyal device with the '876 patent, the district court had found that the Uniroyal device disclosed "a fairing type device, instead of a baffle" to reduce drag for a tractor trailer vehicle. (Appendix B at 50a, *infra*.)

Despite these explicit factual findings of the district court, the Federal Circuit, in its consideration of infringement of that portion of claim 2 (and inferentially of claim 1) of the '876 patent that describes an airflow deflecting "baffle," stated in conclusory terms that Uniroyal's device is "undeniably, a baffle' . . ." and that this claim limitation was met by the Uniroyal device. The Federal Circuit also interpreted footnote 6 of the district court's opinion as "apparently" constituting a factual finding that the Uniroyal devices, "at least in some instances," fell within the scope of claims 1 and 2 of the '876 patent. (Appendix A at 16a-17a *infra*.)

The Federal Circuit therefore reversed those portions of the judgment holding claims 1 and 2 not literally infringed and re-

manded for a determination of the extent of literal infringement. (Appendix A at 17a and 19a, *infra*.)

C. *Failure to Review Entire Record*

The Federal Circuit thus (a) reversed (without remand) the district court's factual findings that the prior art as a whole did contain the suggestion for a combination of references; (b) determined that the district court had "erroneously analyzed and weighed secondary considerations of nonobviousness" and then found on its own, in conflict with a factual finding of the district court, that it was the uniqueness of the Saunders invention which caused the trucking industry to increase its demand for the device after the oil crisis, and further found that "the secondary evidence as a whole strongly suggests the nonobviousness of the invention"; and (c) found on its own, in conflict with the district court, that the Uniroyal device is a "baffle." But the Federal Circuit took such action and made such findings without ever reviewing in its entirety the record which had been before the district court. To the contrary, the docket sheets of the Federal Circuit and of the district court indicate that no request for the entire record was ever made by the Federal Circuit; and consequently only those portions of the record reproduced in the appendix to the Federal Circuit have ever been in the possession of the Federal Circuit for its review.[4] The remainder of the record has remained on file in the district court throughout the appellate proceedings.[5]

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4 In Appendix F (78a-84a, *infra*) Uniroyal has reproduced all entries through May 11, 1988 under "Proceedings and Orders" on the docket sheets of the Federal Circuit in this appeal No. 86-1300 and all entries on the district court docket sheets in Civil N-75-81 (EBB) and B-80-281 (EBB) from the date the district court judgments were entered on April 17, 1986 through May 11, 1988. As noted on page 2, *supra*, Uniroyal's suggestion for rehearing in banc was declined May 10, 1988.

5 Pursuant to Fed. Cir. R. 11(a)(4) and Fed. R. App. P. 11(e), all papers in the record are to be retained by the district court unless ordered by the Federal Circuit, on motion or *sua sponte*, at any time during pendency of the appeal.

SUMMARY OF THE REASONS FOR GRANTING THE PETITION

We respectfully submit that certiorari should be granted for the following reasons:

A. Contrary to the controlling precedent found in *Anderson v. City of Bessemer City, North Carolina*, 470 U.S. 564 (1985) and *Icicle Seafoods, Inc. v. Worthington*, 475 U.S. 709 (1986), the Federal Circuit has, upon a review of no more than the evidence reproduced in the appendix to the Federal Circuit and not of the entire record as defined and referred to in Fed. R. App. P. 10(a) and Fed. Cir. R. 11(a)(1) and (4):

(i) reversed the judgment of the district court (declaring the '876 patent invalid) on the grounds that there was no evidence of a teaching or suggestion in any of the prior art references, or in the prior art as a whole, that would lead one of ordinary skill in the art to combine the references of record;

(ii) set aside and reversed factual findings of the district court on the grounds that the district court "erroneously analyzed and weighed secondary considerations of nonobviousness," when, as evidenced by the conclusion on the same question reached with regard to the Saunders' invention by the Seventh Circuit in *Saunders* v. *Air Flo Co.*, 646 F.2d at 1208, such findings were based on at least a permissible view of the evidence;

(iii) impermissibly made, on its own, factual findings: (a) pertaining to secondary considerations and (b) that the Uniroyal device, which the district court had found from the evidence constituted "a fairing type device, instead of a baffle," was, in fact, a baffle;

(iv) determined that the district court made findings of at least some instances of literal infringement of claims 1 and 2 of the '876 patent when the findings of the district court do not warrant such an interpretation.

B. Given the structure of the appellate rules and the burden upon the appellant to show error, an appellee should not be required to see that all evidence is reproduced in the appendix or suffer the peril that the Federal Circuit will, on the basis of a review of no more than the evidence reproduced in the appendix, conclude that the findings of the district court are based on insufficient evidence or are otherwise "clearly erroneous" under Fed. R. Civ. P. 52(a); and that it will order judgment contrary to the judgment of the district court on the basis of such limited review. If such action by the Federal Circuit or any court of appeals becomes permissible, the carefully-structured rules of appellate procedure will, *de facto*, be materially amended; and appellees will be forced, as a practical matter, to disregard the express safeguards of Fed. R. App. P. 10(a) and 30(b) and to include in an appellate appendix all evidence supporting each factual finding of the district court which they feel may conceivably be challenged. Also, acceptance of such a standard of review has a significant potential for adversely affecting the administration of justice and the morale of district judges whose findings may be gauged, not by an objective examination of the evidence which was actually before them, but by an examination of whatever evidence an appellee's counsel had the foresight to include in an appellate appendix.[6]

C. There is sufficient evidence in the portions of the record reproduced in the appendix independently, as well as in the record as a whole, to sustain as permissible views of the evidence—not subject to being set aside as clearly erroneous—the factual findings of the district court referenced in subparagraphs A(i), (ii) and (iii) of this Summary of the Reasons for Granting the Petition. Further, the conclusion of the Federal Circuit concerning literal infringement referenced in subparagraph (A)(iv) of this Summary is clearly an incorrect interpretation of the findings and conclusions of the district court.

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6 *See* Nangle, Hon. John F., *The Ever Widening Scope of Fact Review in Federal Appellate Courts—Is the "Clearly Erroneous Rule" Being Avoided?*, 59 WASH. U. L. Q. 409, 426-427 (1981). *See also Pendergrass v. New York Life Ins. Co.*, 181 F.2d 136, 138 (8th Cir. 1950).

ARGUMENT

POINT I

BY SETTING ASIDE AND REVERSING THE JUDGMENT UPON REVIEW OF NO MORE THAN THE PARTIAL RECORD IN THE APPENDIX, THE FEDERAL CIRCUIT HAS UNDERMINED THE FOUNDATIONS OF THE RULES OF APPELLATE PRACTICE

In its barest form, the present petition seeks review of an issue fundamental to the soundness of the federal judicial system and to the fulfillment by the district courts of their proper role in that system:

> Can a court of appeals which has not reviewed all of the evidence which was before the district court on various issues, nevertheless set aside factual findings of the district court on those issues, make independent findings without remand and then reverse the judgment of the district court which had been based upon the district court's finding. ?

The federal rules of civil and appellate procedure have been carefully crafted so that each level of the judiciary can perform its own function. As here pertinent, Rule 52(a), Fed. R. Civ. P., provides that in a bench trial the district court shall find the facts specially and shall state separately its conclusions of law thereon. On appeal, findings of fact, whether based on oral or documentary evidence, shall not be set aside unless clearly erroneous; and due regard shall be given to the opportunity of the trial court to judge the credibility of witnesses. Before a court of appeals can set aside findings of fact as clearly erroneous, it is obligated to review the record in its entirety. *Anderson v. City of Bessemer City*, 470 U.S. at 574. Further, if the court of appeals believes that the district court has failed to make findings of fact essential to the proper resolution of a legal question, it should remand so that the district court can make the necessary findings. *Icicle Seafoods, Inc. v. Worthington*, 475 U.S. at 714. Only where the court of appeals concludes that the district court's factual findings are unassailable but that the proper rule

of law was misapplied to those findings, can the court of appeals reverse the district court's judgment. *Id.* The actions of the Federal Circuit on which we seek review have, we submit, so far departed from the accepted and usual course of judicial proceedings as to call for an exercise of this Court's power of supervision. Without such intervention, such actions threaten to undermine the foundations of federal appellate practice.

The Federal Rules of Appellate Procedure provide a comprehensive procedural framework for getting before a court of appeals, to the extent necessary for its decision, underlying evidence which may support, or may prove insufficient to support, the factual findings of the district court. Under Rule 10(a), Fed. R. App. P., the original papers and exhibits filed in the district court, the transcript of proceedings, if any, and a certified copy of the docket entries prepared by the clerk of the district court "shall constitute the record on appeal in all cases." As here pertinent, if the entire transcript is to be included in the record (as was true in the present case), the obligations of the parties under Rule 10(b) regarding the contents of the record are satisfied. See 9 *Moore's Federal Practice*, 2d ed., ¶ 210.05[1], p. 10-22.[7]

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7 Rule 10 also recognizes that the entire transcript may not necessarily be prepared, and therefore provides that if the appellant intends to urge on appeal that a finding or conclusion is unsupported by the evidence, the appellant shall include in the record all evidence relevant to such finding or conclusion; and, unless the entire transcript is to be included, the appellant shall, within ten days after filing the notice of appeal, file and serve upon the appellee a statement of the issues the appellant intends to present on appeal so that the appellee can designate additional parts of the transcript to be included if he deems them necessary. In this way the rules make provision by which the parties can seek to avoid a situation in which the court of appeals is, because of an insufficient record, precluded from determining that findings of fact are unsupported by the evidence or otherwise clearly erroneous. See, e.g., *Jensen v. United States*, 326 F.2d 891, 893 (9th Cir. 1964); *Green v. Aetna Ins. Co.*, 397 F.2d 614, 615, 618-9 (5th Cir. 1968); *Wyoming Farm Bureau Mutual Ins. Co. v. Smith*, 377 F.2d 918, 919-20

Rule 30(b), Fed. R. App. P., provides a means by which the parties shall include in an appendix *parts* of the record to which the parties wish to direct the particular attention of the court of appeals. To assist the appellee in deciding what evidence to designate, the rule also requires that the appellant serve with its designation of parts of the record a statement of the issues which the appellant intends to present for review. The rule imposes no degree of specificity, however; and nothing required by the rule is necessarily sufficient to alert an appellee as to what factual findings may be challenged by an appellant or a court of appeals.[8] Certainly, the general statement furnished in the present case (Appendix G at 85a, *infra*) in no way served to narrow the issues as to what specific evidence received at trial might be relevant to the issues on appeal except to exclude evidence on damages.[9]

The permissible generality of the statement of issues under Rule 30(b) ordinarily should have no adverse impact on an appellee. In at least two places Rule 30 makes clear that what is printed in the appendix does not affect the scope of the record on appeal. Thus Rule 30(a) provides that the fact that parts of the record are not included in the appendix shall not prevent the

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(9th Cir. 1967). The rules also make provision for correction of the record, where necessary. Rule 10(e), Fed. R. App. P.

8 Even under the far more critical provisions of Fed. R. App. P. 10(b), pertaining to preparation of the record, considerable latitude is given as to the specificity of appellant's statement of issues. See 9 *Moore's Federal Practice*, 2d ed., ¶ 210.05[2], pps. 10-30 to 10-32. In that circumstance, however, the rule imposes an affirmative burden on an appellant who intends to urge that a finding or conclusion is unsupported by the evidence or is contrary to the evidence to include in the record a transcript of all evidence relevant to such finding or conclusion.

9 Despite the fact that issues on damages were clearly not relevant to the appeal in the light of the district court's findings of invalidity and non-infringement, Rudkin-Wiley, for reasons of its own, included a footnote in its brief to the Federal Circuit stating the amount of the *claimed* damages on which it had "introduced evidence at trial".

parties or the court from relying on such parts; and Rule 30(b) provides that in designating parts of the record for inclusion in the appendix, the parties shall have regard for the fact that the *entire record* is always available to the court for reference and examination and shall not engage in unnecessary designation. See also Fed. Cir. R. 11(a)(4).

The parties to the present appeal followed the procedure of Rule 30 by which appellant Rudkin-Wiley designated certain portions of the record for inclusion in the appendix and appellee Uniroyal thereafter designated additional parts. (Appendix G at 85a[10]) Uniroyal did not attempt to include *all* of the evidence which had been before the district court or all evidence which supported each of the district court's extensive factual findings. To have done so would have been inconsistent with Rule 30(b)'s admonition against "unnecessary designation."

Nothing in the appellate rules suggests that an appellee is required to do more than Uniroyal has here done. The Federal Circuit has repeatedly stated that, on appeal, the party subject to the adverse judgment on the issue of validity (here Rudkin-Wiley) bears the burden of showing either that the district court committed reversible legal error in its ultimate conclusion as to obviousness, or that the district court's probative factual findings underlying its ultimate conclusion on obviousness were clearly erroneous. *Ashland Oil, Inc. v. Delta Resins & Refractories, Inc.*, 776 F.2d 281, 292 (Fed. Cir. 1985) *cert. denied*, 475 U.S. 1017 (1987); *Fromson v. Advance Offset Plate, Inc.*, 755 F.2d 1549, 1555 (Fed. Cir. 1985); *Preemption Devices, Inc. v. Minnesota Mining & Mfg. Co.*, 732 F.2d 903, 905 (Fed. Cir.

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10 Although Rudkin-Wiley as appellant identified the appendix as "joint" on printing it, the parties (as shown in Appendix G at 85a, *infra*) in fact used the appellant-designation/appellee-designation procedure provided for in Rule 30(b). Under the rules, however, the method utilized to prepare the appendix does not affect the scope of the record. Compare Rule 10(d), Fed. R. App. P., under which, in lieu of the record on appeal as defined in Rule 10(a), the parties may prepare a statement of the case which, together with such additions thereto as the court may consider necessary fully to present the issues raised by the appeal, shall be approved by the district court and then certified to the court of appeals as the record on appeal.

1984). A standard which shifted to an appellee the burden of including in the appendix all of the evidence supporting each finding would be wholly inconsistent with appellant's burden thus to show error as well as with the relevant provisions of Rules 10 and 30, Fed. R. App. P., discussed above.

If an interpretation of the Federal Rules of Appellate Procedure is permitted to stand that *de facto* imposes upon an appellee the burden of including in the appendix all evidence of record which tends to support the factual findings of a district court, the result will be chaos in the appellate process. There is effectively no way that an appellee can know at the time an appendix is prepared that an appellant, or an appellate court acting *sua sponte*, will not challenge critical findings of the district court as inadequately supported or as inconsistent with other evidence (and thus, in either case, as clearly erroneous) on the basis of an appendix which includes none, or only part, of the evidence relating to each such finding. The practical consequence of such an interpretation of the rules, therefore, will be to force each appellee to include in the appendix all of the evidence which he believes provides support for each significant finding. A change in federal appellate procedure of such fundamental proportions is beyond the power of a court of appeals.

POINT II

DESPITE ITS REVIEW OF NO MORE THAN A PART OF THE RECORD, THE FEDERAL CIRCUIT HAS MADE FACTUAL FINDINGS INCONSISTENT WITH PERMISSIBLE DISTRICT COURT FINDINGS

A. Suggestion for Combining References

1. Knowledge Possessed by One of Ordinary Skill in Art

With respect to the obviousness determination in the present case, one of the unchallenged factual findings that the district court made pursuant to the requirements of *Graham* was that the level of ordinary skill in the pertinent art at the time the invention was made was that of an engineer familiar with aerody-

namic or fluid mechanic principles. (Appendix B at 38a-39a, *infra*.) During the course of the lengthy trial, the district court had witnessed in-court experimental presentations and videotapes of airflow tests and had heard extensive expert testimony. Much of this evidence related to aerodynamic and fluid mechanic principles with which such an engineer would have been familiar. It was closely analogous to the evidence present in *Graver Tank & Mfg. Co., Inc. v. Linde Air Products Co.*, 336 U.S. 271 (1949). In those patent infringement actions, the Court stated with reference to Fed. R. Civ. P. 52(a)'s requirement that due regard be given to the opportunity of the trial court to judge the credibility of witnesses, that "[t]o no type of case is this last clause more appropriately applicable than to the one before us, where the evidence is largely the testimony of experts as to which a trial court may be enlightened by scientific demonstrations." *Id.* at 274. See also *Graver Tank & Mfg. Co., Inc. v. Linde Air Products Co.*, 339 U.S. 605, 609-612 (1950). Before the Federal Circuit could properly reverse the judgment of the district court in the present case on the grounds that there was no teaching or suggestion in any of the prior art references, or in the prior art as a whole, that would lead one with ordinary skill in the art to make the combination (837 F.2d at 1052, Appendix A at 11a, *infra*), it was essential for the court to consider *all* of the evidence—not only as to the contents of specific prior art references but also as to the relevant principles of aerodynamics and fluid mechanics—establishing with what such a person would have been familiar. This the court clearly did not do. Under such circumstances, the Federal Circuit's reversal of the district court's judgment of invalidity cannot be sustained on the basis of the appellate review made to date.

2. Evidence in Appendix Justified District Court Finding

To the extent that the Federal Circuit simply regarded the underlying factual findings of the district court as insufficient to support the court's conclusion that the combination of the teachings of the prior art would have suggested to one of ordinary skill at the time the invention was made, the combining of such teachings along the line of the '876 patent, the Federal Cir-

cuit was required either to call up the complete record for review in its entirety or to remand to the district court for further findings on validity. *Icicle Seafoods, Inc. v. Worthington*, 475 U.S. at 714; *Anderson v. City of Bessemer City*, 470 U.S. at 574; see also *Panduit Corp. v. Dennison Mfg. Co.*, 810 F.2d 1561, 1565 (Fed. Cir.), *cert. denied*, ____ U.S. ____, 107 S.Ct. 2187 (1987); *Loctite Corp. v. Ultraseal Ltd.*, 781 F.2d 861, 875 (Fed. Cir. 1985). Its failure to do either requires that its decision be set aside.

Even without the necessity of referring to other portions of the complete record that the district court might re-examine on remand, however, we submit that evidence already printed in the appendix to the Federal Circuit (and reproduced at Appendices K and L), fully supports the district court's conclusion concerning the suggestion for the combination. If certiorari is granted, we believe that this Court can and should enter an order which would have the effect of reinstating the district court's judgment that the '876 patent is invalid.

Following its establishment in 1982, the Court of Appeals for the Federal Circuit acting in banc held that the holdings of its predecessor courts, the United States Court of Claims and the United States Court of Customs and Patent Appeals, would be binding precedent before it. *South Corp. v. United States*, 690 F.2d 1368, 1369 (Fed. Cir. 1982). Thereafter, in *In re Sernaker*, 702 F.2d at 994, the court outlined a two-part inquiry which it stated had been applied in six identified decisions of the former Court of Customs and Patent Appeals to determine the obviousness of combining references:

> (1) Whether a combination of the teachings of all or any of the references would have suggested (expressly or by implication) the possibility of achieving further improvement by combining such teachings along the line of the invention in suit, and
>
> (2) Whether the claimed invention achieved more than a combination which any or all of the prior art references suggested, expressly or by reasonable implication.

In the instant case the district court made this two-part inquiry and explicitly found, as to question (2) above, that the '876 patent did not achieve more than the combination of prior art references suggested. (Appendix B at 42a, *infra*.) As to question 1, the district court found that the combination of the teachings of the prior art references would have suggested to one of ordinary skill in the art, the combining of such teachings along the line of the '876 patent. (*Id.*) Noting the suggestions in the Maryland studies and in Stamm for mounting add-on streamlining devices to the tractor roof, and the suggestion in Constantin and the aerodynamic literature that the use of a simple blunt-edged deflector placed in front of a large bluff body will reduce drag, the district court found that such prior art references would have suggested to an engineer with knowledge of aerodynamic principles at the time the invention claimed in the '876 patent was made, the design of a wind-deflecting baffle that could be easily mounted on top of a tractor cab. (*Id.*) In an explicit determination of whether there was something in the prior art that suggested the desirability of making the combination, the district court found that the fact that both Constantin and Stamm revealed in their statement of the purpose an awareness of the problems of wind resistance faced by vehicles with large carrying capacities revealed that it would have been desirable and obvious to one of ordinary skill in the art at the time to make the combination. (*Id.*)

The decisions referenced by the Federal Circuit in *Sernaker* as accurately reflecting the standards applicable to combining patents emphasize that the suggestion for a combination may be implied rather than express and is based upon "what the references taken collectively would suggest to those of ordinary skill in the art *presumed* to be familiar with them. . . ." *In re Conrad*, 439 F.2d 201, 205 (CCPA 1971) (emphasis in original); see also *In re Sheckler*, 438 F.2d 999, 1000-1 (CCPA 1971). Moreover, the cases make clear that the bar to the use of "hindsight" precludes only testing for obviousness on the basis of knowledge which arises solely from the applicant's disclosure. Thus, in *In re McLaughlin*, 443 F.2d 1392, 1395 (CCPA 1971), the

court analyzed as follows the requisite suggestion for a combination found in prior art references:

> Any judgment on obviousness is in a sense necessarily a reconstruction based upon hindsight reasoning, but so long as it takes into account only knowledge which was within the level of ordinary skill at the time the claimed invention was made and does not include knowledge gleaned only from applicant's disclosure, such a reconstruction is proper.

The decision of the Federal Circuit that the district court in the present case improperly used hindsight cannot be reconciled with these standards. The explicit findings of the district court clearly establish that the prior art suggested the combination; further the two most pertinent prior art references analyzed by the district court were the 1958 Stamm patent (Appendix K) and the 1913 Constantin patent (Appendix L). (See Appendix B at 32a-34a, *infra*.) Stamm teaches that the drag on a tractor-trailer can be reduced by mounting a streamlining device (a conduit or turning vanes) on the rear portion of the tractor roof to direct the airflow smoothly away from the exposed face of the trailer and onto the top and sides of the trailer. (Appendix B at 32a-33a, *infra*.) Element b of fig. 1 of Constantin (Appendix L) is described and depicted in the patent as a flat baffle, that, using a principle which the Federal Circuit acknowledged (837 F.2d at 1052, Appendix A at 11a, *infra*) is the antithesis of streamlining, will reduce air resistance by deflecting the airstream away from the front of a bluff body. (Appendix B at 32a, *infra*.) Element b of fig. 2 of Constantin (Appendix L at A107) is a shallow conical shield which operates on the same principle. (Appendix E at 62a-65a, *infra*.) When one considers the disclosure of Constantin in its entirety, however, he observes that figs. 5 and 6 of Constantin show the use of parallel sheets positioned so as to form conduits which would, *through streamlining*, direct the air around the bluff face of the vehicle whose drag is to be reduced. (Appendix L; Appendix E at 63a-65a, *infra*.) This device nearly duplicates the device mounted at the

rear of the tractor roof that fig. 2 of Stamm discloses. (Appendix K)

Consequently, within these two references alone, there is the unmistakable suggestion to an engineer familiar with aerodynamic and fluid mechanic principles at the time Saunders' invention was made that, although streamlining and non-streamlining devices operate on different principles and in ways which are antithetical to each other, *either* streamlining devices (such as those disclosed by Stamm or figs. 5 and 6 of Constantin) or a non-streamlining baffle (such as figs. 1 and 2 of Constantin) could be mounted on a tractor to reduce the drag on the trailer face. The Federal Circuit never alluded to such facts when it found error by reason of the asserted absence of a teaching or suggestion for the combination in any of the references, or in the prior art as a whole. Moreover, the Federal Circuit in its discussion of Constantin clearly did not consider the Constantin patent in its entirety when it concluded that the patent did not disclose a convex shape or a rearward inclination as claimed in the '876 patent. (837 F.2d at 1052, Appendix A at 9a, *infra*.) As noted above, element b of fig. 2 of Constantin, and the description of same, disclose an alternate shape to the flat plate deflector, which alternate deflector can be in the shape of a shallow cone. (Appendix E at 62a-63a, *infra*.) As such a shallow cone pointed forward, the deflector would have a rearward inclination and be forwardly convexed in a horizontal plane. Under the well-recognized aerodynamic principle of "imaging" (Appendix E at 71a-74a, *infra*; Appendix N at A129)—a principle which Saunders himself utilized in drawing conclusions from his disc/cylinder experiments as depicted in fig. 7 of the '876 patent (Appendix J; Appendix E at 73a, *infra*)—the upper half of this shallow cone would correspond closely with the structure of the baffle described in the '876 patent.

By no stretch of the imagination would it have been necessary for an engineer skilled in aerodynamic and fluid mechanic principles at the time the Saunders invention was made to go beyond his own presumed knowledge of the then-existing pertinent art—including other literature which the district court found disclosed that a simple blunt-edged deflector placed in

front of a large bluff body can reduce drag—in order to combine Stamm and Constantin. We respectfully urge that, if this Court grants certiorari, it should either affirm the district court's judgment on obviousness or remand for further consideration of the relevant issues by the courts below. Further, since the decision of the Federal Circuit in this case has obscured the standard of "hindsight" heretofore articulated by the Federal Circuit, the grant of certiorari will enable this Court to provide with regard to this critical element of an "obviousness" determination a clear standard which can guide the lower courts.

B. Weighing Secondary Considerations

Although the Federal Circuit reviewed no more than a partial record, it nevertheless set aside factual findings concerning such matters on the ground that the district court "erroneously analyzed and weighed" them (837 F.2d at 1051, Appendix A at 8a, *infra*); and the Court proceeded, on its own, affirmatively to find facts on such issues. Such actions constitute error. *Anderson v. City of Bessemer City*, 470 U.S. at 574-575; *Icicle Seafoods, Inc. v. Worthington*, 475 U.S. at 714; *Pullman-Standard, Div. of Pullman, Inc. v. Swint*, 456 U.S. 273, 291-293 (1982). Moreover, as discussed further below, the Federal Circuit found such facts in contravention to clearly "permissible" factual findings of the district court.

On the basis of the entire record before it, the district court made the basic factual inquiries required by *Graham*, 383 U.S. at 17, and, as required, it examined the various secondary considerations such as the level of commercial success attained by the patent, unexpected results, long-felt but unsolved need for the patent's utility, and the failure of others, which this Court has indicated may have relevancy (*id.* at 18) and which the Federal Circuit has indicated *must* be considered in all cases. See, e.g., *Interconnect Planning Corp. v. Feil*, 774 F.2d 1132 at 1144 (Fed. Cir. 1985).

In its analysis of the scope and content of the prior art, the district court found that the wind tunnel tests of models of Trailmobile trailers conducted at the University of Maryland

had all used conventional streamlining approaches to reduce drag. (Appendix B at 32a, *infra*.) The evidence indicated that these tests had been conducted for Trailmobile Inc. (Appendix E at 75a-76a, *infra*) and that, after they had been concluded, Trailmobile Inc. in conjunction with the American Trucking Associations Foundation, Inc., had published a 16-page brochure outlining hypothetical approximate annual fuel savings from various streamlined configurations of trailers and had invited readers to send to Trailmobile for information on their own potential savings. (Appendix M at A125.) Rudkin-Wiley cited this brochure—obviously promotional in nature—to the Federal Circuit as showing long felt need and failure of others.

The district court found that there was no long-felt need for such a device. (Appendix B at 40a, *infra*.) *A fortiori*, it made no finding that others had failed to meet such a need. To the contrary, the district court found on the basis of the *complete* record before it, that despite vigorous promotional efforts launched by Rudkin-Wiley after it had acquired exclusive rights to the '876 patent in 1966, the trucking industry had remained essentially unreceptive to Rudkin-Wiley's deflector for some seven years and until the oil crisis in 1973 created a demand for a fuel-saving device. (Appendix B at 39a-40a, *infra*.) The district court concluded that whether others would have produced a similar device was unknown since there had been no impetus to invent a gas-saving device until the 1973 oil crisis. (Appendix B at 40a, *infra*.)

Given (a) the absence of evidence that persons other than Stamm[11] and the individuals conducting experiments sponsored by Trailmobile (which had an obvious interest in promoting the

11 Although, as the district court found, there was no evidence that the Stamm device had ever been commercialized, there was also no finding that Stamm's invention would not successfully have reduced drag and lowered fuel consumption. (See Appendix E at 65a-68a, *infra*.) Since the 1958 Stamm patent had little life remaining at about the time the oil crisis was commencing in late 1973, the absence of commercialization of Stamm during the period from 1958 through 1973 is consistent with the same absence of industry interest in an add-on fuel saving device that Rudkin-Wiley found to exist during the cheap-fuel years which had preceded the oil crisis.

sale of streamlined trailers) had addressed the question of reducing fuel consumption of tractor-trailer combinations; (b) the clear evidence that the trucking industry showed little interest in the Rudkin-Wiley device so long as fuel remained cheap; and (c) the fact that there was evidence from which the district court could find that, with cheap fuel, reductions of fuel consumption of the sort Rudkin-Wiley was touting during 1966-73 would not translate into significant cost savings,[12] the record was certainly such that the district court was *not compelled* to accept Rudkin-Wiley's arguments of commercial success following failure of others. In fact—as the district court explicitly noted in its opinion—the district court's finding on this point was essentially the same as the one sustained by the Seventh Circuit in rejecting Rudkin-Wiley's arguments in *Saunders v. Air-Flo Co.*, 646 F.2d at 1208, that such commercial success as Rudkin-Wiley enjoyed after the oil crisis reflected long-felt need and the failure of others. (Appendix B at 40a, *infra.*)

The relevant standard adopted by this Court is that "[w]here there are two permissible views of the evidence, the factfinder's choice between them cannot be clearly erroneous." *Anderson v. City of Bessemer City*, 470 U.S. at 574, citing *United States v. Yellow Cab Co.*, 338 U.S. 338, 342 (1949) and *Inwood Laboratories, Inc. v. Ives Laboratories, Inc.*, 456 U.S. 844 (1982). The most skilled magician would be hard-pressed to conjure more dramatic evidence than is provided by the trial and appellate opinions in *Saunders*, that the district court's opinion in the present case amounted, at a minimum, to a "permissible" view of the evidence concerning secondary considerations.

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12 The promotional brochure containing information developed at the University of Maryland in studies of drag reduction sponsored by Trailmobile, Inc. contained fuel-saving estimates for various streamlined trailer configurations on the basis of hypothetical annual tractor trailer mileage of 60,000 miles, fuel consumption of 4 miles per gallon and fuel cost of $0.24 per gallon (Appendix M at A125); Rudkin-Wiley's president testified that his company advised prospective customers that, they could save 4 to 6 percent fuel per year with Rudkin-Wiley's deflector. (Appendix E at 69a, *infra.*) At the above hypothetical mileage and fuel consumption/cost figures, a 4 percent reduction would translate to a cost saving of less than $150 per year.

The fundamental standards which this Court has established to prevent courts of appeal from conducting *de novo* review of factual findings must be fully and regularly observed by all such courts. This case, involving what amounts to such review both impermissibly on only a partial record and where an objective yardstick exists as to the permissible nature of the district court's findings with which the Federal Circuit disagreed, provides a strong vehicle for enforcing adherence to such standards.

C. Finding Uniroyal Device to be a Baffle Rather Than a Fairing

As discussed at page 11, *supra*, the district court had found on the extensive evidence before it that, by contrast with the essentially flat-plate, high-drag baffle described in the '876 patent, the accused Uniroyal device was a streamlined, low-drag "fairing type device, instead of a baffle." It had found further that, much like a fairing, the Uniroyal deflector was designed to allow the flow to be guided in a precise manner so as to leave the trailing edge of the device smoothly and without abrupt change of direction and to attach at an optimum location on top of the trailer. (Appendix B at 49a, *infra*.) Rudkin-Wiley itself had argued years earlier in its brief to the Seventh Circuit in its case against Air-Flo Co. (see p. 10, *supra*), of course, that a fairing is a streamlining device which operates in a manner "diametrically opposite" to the Saunders baffle, the latter device being one "which obstructs rather than conducts flow".

Early in its opinion, the Federal Circuit defined a "fairing" as "a deflector which changes the direction of an airflow in a streamlined or continuous manner along the curvature of the fairing"; and it defined a "baffle" as "a deflector that abruptly changes the direction of an airflow." (837 F.2d at 1048 n. 3, Appendix A at 3a n. 3, *infra*.) The definition that the Federal Circuit so gave for a "baffle" was consistent with the district court's findings concerning the operation of the '876 device; and the definition that it so gave for a "fairing" was consistent with the district court's findings concerning the operation of the Uniroyal device. In its discussion of infringement, however, the

Federal Circuit thereafter ignored both its own definitions and the pertinent factual findings of the district court. In direct conflict with both, and without citation to any supporting finding by the district court or to any evidence in the record, the Federal Circuit found en route to its determination of literal infringement of claims 1 and 2 of the '876 patent, that "Uniroyal's device is undeniably 'a baffle mounted to extend above the tractor cab roof,' . . ." within the meaning of those claims. (837 F.2d at 1055, Appendix A at 16a, *infra.*)

Not only does this unsupported finding by the Federal Circuit conflict with the detailed factual findings of the district court, but it is also inconsistent with extensive evidence in the record upon which the district court relied—including both those portions of the record included within the appendix to the Federal Circuit and other portions which the Federal Circuit clearly has not reviewed. The finding is also inconsistent with the approval given by the Federal Circuit to the factual findings of the district court that the baffle principle exemplified by the '876 patent and by figs. 1 and 2 of Constantin (Appendix L) is antithetical to streamlining. (837 F.2d at 1052, Appendix A at 11a, *infra.*) Consistent with the definition of "baffle" which the Federal Circuit itself adopted, the finding of the district court that the Uniroyal device is a "fairing type device, instead of a baffle" is fully supported both by the parts of the record included in the appendix to the Federal Circuit and by other portions of the record. We respectfully submit that, if this Court grants certiorari, it will conclude that it should set aside the impermissible findings of the Federal Circuit and should reinstate the contrary findings of the district court.

D. Finding of Literal Infringement

Nowhere in the opinion of the district court is there a finding of infringement. After reaffirming the doctrine that literal infringement is a factual inquiry reviewed on a clearly erroneous standard, however, the Federal Circuit stated concerning alleged infringement of claims 1 and 2 that "[i]t was apparently established that the Uniroyal devices, at least in some instances, fall within the scope of these limitations." (837 F.2d at 1054-6, Appendix A at 15a-17a, *infra.*) The Federal Circuit cited the

district court's footnote 6 as providing support for this conclusion. But in that footnote the district court had merely restated in general terms Rudkin-Wiley's *arguments* concerning claims 1, 2 *and 3* (and inferentially dependent claim 4). Claims 3 and 4 claim broad height ratios (between 0.5 and 0.9) and distance ratios (between 0.3 and 2.0); and the Federal Circuit left undisturbed the district court's findings that claims 3 and 4 are not literally infringed. In the statement of Rudkin-Wiley's argument set forth in footnote 6 (Appendix B at 51a-52a, *infra*), the district court had referred to the fact that Rudkin-Wiley had argued that a half-width of a standard trailer would be 48 inches and that trailers would usually be located between 24 and 60 inches from the back of the cab. This would equate to a range of distance ratios between 0.5 [24 divided by 48] and 1.25 [60 divided by 48]--i.e., within the ranges of claims 3 and 4 but in no way establishing, even if accepted, that any accused device had ever actually been installed so that the relevant height and distance ratios coincided at 0.7 as required by claims 1 and 2. The district court has not yet interpreted the 0.7 ratios of claims 1 and 2. To the contrary, the Federal Circuit has explicitly remanded the case to the district court for an interpretation of the height and position ratios of claims 1 and 2 in light of the specification and prosecution history to determine the literal coverage of the claims. By no interpretation, therefore, can the district court's footnote 6 be deemed a factual finding that in *any* actual installations claims 1 and 2 are met by the Uniroyal device. If certiorari is granted, we submit that this erroneous interpretation of the district court's opinion should be set aside.

CONCLUSION

The petition for a writ of certiorari should be granted.

RESPECTFULLY SUBMITTED,

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APPENDICES A THROUGH I TO PETITION FOR WRIT OF CERTIORARI

Court of Appeals Decision

UNITED STATES COURT OF APPEALS
FOR THE FEDERAL CIRCUIT

86-1300

UNIROYAL, INC.,

Plaintiff-Appellee,

v.

RUDKIN-WILEY CORPORATION,

Defendant-Appellant.

PREMIX, INC.,

Plaintiff-Appellee,

v.

RUDKIN-WILEY CORPORATION,

Defendant-Appellant.

Francis T. Carr, of Kenyon & Kenyon, New York, New York, argued for appellant. With him on the brief were *Robert D. Fier*, *Albert J. Breneisen* and *John D. Vandenberg*, of Kenyon & Kenyon, New York, New York.

William R. Murphy, of Tyler Cooper & Alcorn, New Haven, Connecticut, and *Thomas A. Beck*, of Felfe & Lynch, New York, New York, argued for appellees.

Appealed from: U.S. District Court
for the District of Connecticut
Judge Burns

Decided: January 13, 1988

Before

DAVIS, NEWMAN and ARCHER,
Circuit Judges.

ARCHER, *Circuit Judge.*

Rudkin-Wiley Corporation (Rudkin-Wiley) appeals the judgment by the United States District Court for the District of Connecticut holding U.S. Patent 3,241,876 ('876 patent or Saunders' patent) invalid for obviousness under 35 U.S.C. § 103 (1982 and Supp. III 1986) or, if valid, not infringed by Uniroyal, Inc. or its successor in interest, Premix, Inc. (collectively, Uniroyal). We affirm-in-part, vacate-in-part, reverse-in-part and remand.

BACKGROUND

This case was initiated by Uniroyal in 1975 by the filing of a declaratory judgment action to have the '876 patent declared invalid or, if valid, not infringed by Uniroyal. Premix filed a similar action immediately after its purchase of Uniroyal's deflector business in 1980. Rudkin-Wiley counterclaimed for infringement. The cases were consolidated and proceedings were stayed pending an appeal of a separate action involving the '876 patent. *See Saunders v. Air-Flo Co.*, 646 F.2d 1201, 210 USPQ 337 (7th Cir. 1981) (holding that none of the claims of the '876 patent were proved invalid).[1] Following a bench trial, judgment

1 The district court did not accord that decision collateral estoppel effect because it concluded that Austrian Patent No. 63,329 to Constantin, discussed in the text *infra*, was "never given serious attention as prior art." *Cf. Shelcore v. Durham Industries, Inc.*, 745 F.2d 621, 627 n.10, 223 USPQ 584, 588-89 n.10 (Fed. Cir. 1984) (*citing Stevenson v. Sears, Roebuck & Co.*, 713 F.2d 705, 711 n.5, 218 USPQ 969, 974 n.5 (Fed. Cir. 1983)). In this appeal, Rudkin-Wiley has not contested the propriety of the district court's action.

was rendered in the present case in March, 1986 in favor of Uniroyal, on the basis that the '876 patent is invalid under section 103 or, if valid, was not infringed by the Uniroyal device.

The '876 patent, issued March 11, 1966 to Walter Selden Saunders (Saunders), relates to an air-deflecting device for reducing wind resistance encountered by tractor-trailer combination vehicles.[2] Rudkin-Wiley obtained an exclusive license under the '876 patent from Saunders in 1966. The claimed device is a panel-like deflector[3] mounted on top of the cab of the tractor, which according to the patent specification "produces a relatively wide diffusion of the air . . . and causes the same to readhere to the body of the truck [sic, trailer] rearwardly of the front portion thereof in a relatively smooth and even manner. . . ." Rudkin-Wiley's commercial embodiment of the Saunders invention is roughly rectangular and has a smaller cross-sectional area than the cross-sectional area of the front face of the trailer that extends above the tractor cab. When the vehicle is in motion, the effective surface area encountering wind resistance is thus decreased and significant fuel savings are achieved because of the reduced resistance or drag.

Independent claim 2 of the '876 patent reads as follows:[4]

> Claim 2. In combination with a tractor-trailer vehicle having a gap between the tractor and the trailer, an air flow deflecting shield comprising
>
> (a) a baffle mounted to extend above the tractor cab roof,
>
> (b) said baffle being vertically inclined rearwardly and forwardly convexed in a horizontal piane,

---

2 The four claims of the '876 patent are appended.

3 There is some dispute between the parties concerning the appropriate terminology. For purposes of this opinion, "deflector" is used as a generic term encompassing any device used to change the direction of an airflow. "Fairing" is used to describe a deflector which changes the direction of an airflow in a streamlined or continuous manner along the curvature of the fairing. "Baffle" and "shield" are used interchangeably to describe a deflector that abruptly changes the direction of an airflow.

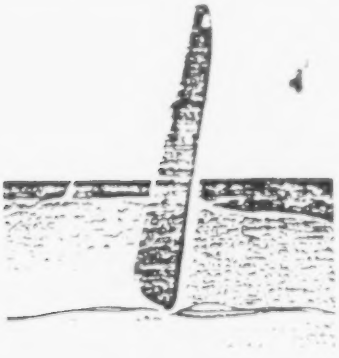
4 Lettered paragraphs have been added for convenience of reference.

(c) said baffle having a predetermined height substantially 0.7 of the difference in height between said cab roof and the trailer roof,

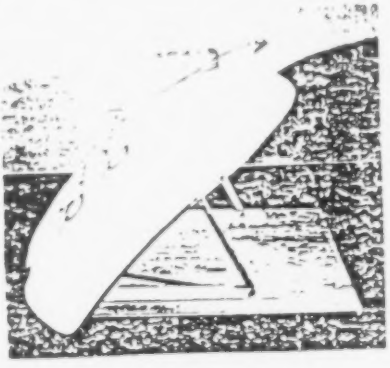
(d) said baffle being positioned a distance from the front of the trailer equal to approximately 0.7 the half width of the trailer.

The accused device of Uniroyal is similar to Rudkin-Wiley's embodiment of Saunders' invention, although it is more rounded on the corners and edges. Uniroyal asserts that its device more closely resembles a fairing and relies to a greater extent on a streamlined, continuous flow around the front surface of the trailer in contrast to the emphasis in the '876 patent on abruptly diverting the airflow about the trailer face.

Rudkin-Wiley's commercial embodiment of the Saunders invention and the Uniroyal device are depicted below:



Rudkin-Wiley



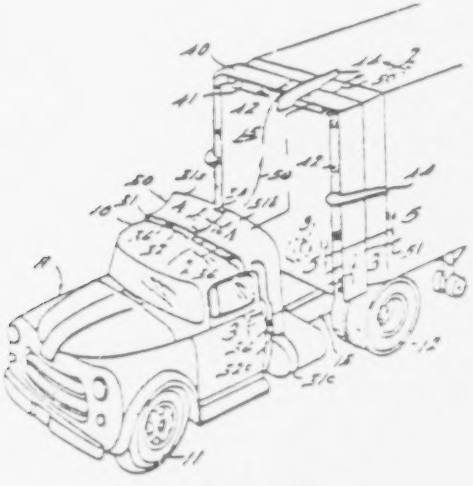
Uniroyal

PRIOR ART

Beginning in 1953 the University of Maryland conducted an extensive study of the wind resistance of tractor-trailer vehicles to seek methods of reducing drag (Maryland study). This study was sponsored by Trailmobile, Inc., a trailer manufacturer, and the American Trucking Association Foundation, Inc. Under the direction of a professor of aerodynamics, the University's Wind Tunnel Operations Department tested over 7,000 config-

urations in wind tunnel tests on trailer models. None of the configurations tested was similar to the invention defined by the claims of the Saunders patent. The study concluded that one of the best drag reduction methods was to use a continuous "fairing." This is a deflector attached to the back of the tractor cab roof which extends in a curved or modified "S" configuration to the top leading edge of the trailer where it is also attached (the Maryland fairing). While the Maryland fairing proved in wind tunnel tests to be very effective at reducing the drag from wind resistance, it was recognized to be impractical, if not useless, because the tractor-trailer could not be turned when such a fairing was employed.

The Stamm patent, U.S. Patent No. 2,863,695 issued on December 9, 1958, discloses an attempt to make a practical device which would produce streamlining effects similar to those of the Maryland fairing. The Stamm device, depicted below, consists of two principal parts, one being curved pieces mounted on the top and sides of the tractor cab and the other being conduits mounted on the top and sides of the trailer. The curved pieces are designed to direct air flow smoothly from the cab through the conduits on the trailer. The district court noted that there is "no evidence that the [invention of the] Stamm patent was ever commercially reproduced."



Stamm Device

Austrian Patent No. 62,329, issued November 15, 1913 to Constantin, was before the district court but it was not considered by the United States Patent and Trademark Office (PTO) examiner in the prosecution of the '876 patent. Constantin discloses "for vehicles with large carrying capacities" the mounting ahead of the vehicle of a shield having a smaller cross-section than the vehicle. It states:

> [I]f one attaches at a suitable distance ahead of the vehicle a shield of suitably shaped cross-section that is smaller than that of the front of the car, the layers of the medium that are deflected by this screen will remove out of the path of the car also other layers that, without the shield, would have struck the vehicle and provided resistance to the motion.

As in the case of Stamm, we have not been directed to, or found in the record, any evidence of commercialization of the Constantin device.

Two patents for bug deflector shields for automobile windshields—Davisson, U.S. Patent No. 2,236,846, and Gracey, U.S. Patent No. 2,148,798—were deemed by the district court to be pertinent to "illustrate a means by which a deflecting shield may be placed," although the court noted there was insufficient evidence to show that these bug-deflecting shields reduced drag.

Several articles and textbooks (see footnote 5, *infra*) discussing the aerodynamics of airflow resistance were also cited by the district court. One general aerodynamic principle described in these publications is "shielding" (also referred to as "favorable interference"), i.e., the use of a smaller cross-sectional deflector in front of a larger surface, which effects a reduction of drag.

OPINION

A. *Validity*

A patent is presumed valid and the burden of establishing invalidity rests on the party asserting such invalidity. 35 U.S.C. § 282 (1982). This presumption may be rebutted only by clear

and convincing evidence. *American Hoist & Derrick Co. v. Sowa & Sons, Inc.*, 725 F.2d 1350, 1360, 220 USPQ 763, 771 (Fed. Cir.), *cert. denied*, 406 U.S. 821, 224 USPQ 520 (1984). The burden of proof is not reduced when prior art is presented to the court which was not considered by the PTO. *Connell v. Sears, Roebuck & Co.*, 722 F.2d 1542, 1549, 220 USPQ 193, 199 (Fed. Cir. 1983). However, reliance upon such art when that art is more pertinent than the art considered by the PTO may facilitate meeting the burden of proving invalidity. *W.L. Gore & Associates, Inc. v. Garlock, Inc.*, 721 F.2d 1540, 1553, 220 USPQ 303, 313 (Fed. Cir. 1983), *cert. denied*, 469 U.S. 851 (1984).

Obviousness under 35 U.S.C. § 103 is a legal conclusion involving a preliminary determination of four factual inquiries: (1) the scope and content of the prior art; (2) the differences between the claims and the prior art; (3) the level of ordinary skill in the pertinent art; and (4) secondary considerations, if any, of nonobviousness. Secondary considerations include objective indicia of nonobviousness such as commercial success, long-felt but unsolved need, and failure of others. *Graham v. John Deere Co.*, 383 U.S. 1, 17-18, 148 USPQ 459, 467 (1966); *Panduit Corp. v. Dennison Mfg. Co.*, 810 F.2d 1561, 1566-1568, 1 USPQ2d 1593, 1596-1597 (Fed. Cir.), *cert. denied*, 107 S. Ct. 2187 (1987).

The factual findings of the district court underlying the obviousness determination will be overturned on appeal only if they are clearly erroneous. *Panduit Corp. v. Dennison Mfg. Co.*, 810 F.2d at 1566, 1 USPQ at 1596. The ultimate conclusion on obviousness, however, is a legal conclusion and is reviewed as such. *Polaroid Corp. v. Eastman Kodak Co.*, 789 F.2d 1556, 1558, 229 USPQ 561, 562 (Fed. Cir.), *cert. denied*, 107 S. Ct. 178 (1986).

The obviousness standard, while easy to expound, is sometimes difficult to apply. It requires the decisionmaker to return to the time the invention was made. "The invention must be viewed not with the blueprint drawn by the inventor, but in the state of the art that existed at the time. . . . That which may be made clear and thus 'obvious' to a court, with the invention

fully diagrammed and aided . . ." by experts in the field, "may have been a breakthrough of substantial dimension when first unveiled." *Interconnect Planning Corp. v. Feil*, 774 F.2d 1132, 1138, 227 USPQ 543, 547-548 (Fed. Cir. 1985).

In this case we are convinced that the district court misapplied the obviousness standard. It has impermissibly used hindsight to reconstruct the claimed invention from prior art with the invention before it and aided by Uniroyal's expert, rather than viewing the invention from the position of a person of ordinary skill at the time it was made. The court also erroneously analyzed and weighed secondary considerations of nonobviousness.

(1) *Hindsight*

"When prior art references require selective combination by the court to render obvious a subsequent invention, there must be some reason for the combination other than the hindsight gleaned from the invention itself." *Interconnect Planning Corp.*, 774 F.2d at 1143, 227 USPQ at 551. *See also Ashland Oil, Inc. v. Delta Resins & Refractories, Inc.*, 776 F.2d 281, 293, 227 USPQ 657, 664 (Fed. Cir. 1985), *cert. denied*, 475 U.S. 1017 (1986). Something in the prior art as a whole must suggest the desirability, and thus the obviousness, of making the combination. *Lindemann Maschinenfabrik GmbH v. American Hoist and Derrick Co.*, 730 F.2d 1452, 1462, 221 USPQ 481, 488 (Fed. Cir. 1984).

Each of the claims at issue defines an airflow deflecting shield or baffle for use on a tractor-trailer vehicle. The shield or baffle is defined in claims 1 and 2 as vertically inclined "rearwardly and forwardly convexed in a horizontal plane" and in claim 3 as an 'upstanding air flow deflecting baffle." There is no suggestion in any individual prior art reference of such a combination of location and configuration nor is it suggested by the prior art as a whole. *Interconnect Planning Corp.*, 774 F.2d at 1143, 227 USPQ at 551; *see also W.L. Gore & Assocs.*, 721 F.2d at 1551, 220 USPQ at 312 (it is impermissible to use the claims as a frame and the prior art references as a mosaic to piece together a facsimile of the claimed invention).

The Maryland fairing is a smooth contoured surface, attached to the cab roof of the tractor and to the roof of the trailer, which covers the "entire gap between the tractor and trailer." Obviously it is structurally quite different and does not approach the rearwardly inclined, horizontally convexed configuration of the claimed invention.

The Stamm device mounts air flow control attachments, or U-shaped conduits, on the top and sides of the rear portion of the tractor cab and conduits on the top and sides of the forward portion of the trailer. These air flow control attachments again are not structurally similar to the claimed invention, nor is there any suggestion of the claimed shape or structure in the Stamm patent. The district court stated that "Stamm essentially is an alternative to using a device that is contiguously connected to the tractor and trailer," i.e., the Maryland fairing.

The district court admitted that the Constantin shield lacked many of the characteristics of the Saunders invention. The court said:

> The Constantin patent shows that a *flat-plated shield*, if placed in front of a larger bluff body, will deflect the air stream away from the front of the bluff body thereby reducing the air resistance. Admittedly, the Constantin patent lacks the sophistication of design that attends most contemporary patents. *It is not concerned with tractor-trailers nor does it reveal information regarding the deflector that is present in the '876 patent: the size, positioning and placement of the deflector.* In fact, it seemingly teaches that the deflector must be placed directly in front of the vehicle; a position Uniroyal interprets as meaning the front of the car radiator. (Emphasis added.)

As indicated, the Constantin patent did not disclose a convex shape or a rearward inclination, as specifically claimed in the '876 patent.

The district court did not conclude that any one of these references would have made the invention of the '876 patent obvious, but it found that it would have been obvious to combine the disclosures of such references to achieve the claimed struc-

ture. It said "the combination of teachings . . . would have suggested the possibility of achieving further improvement . . . along the line of the '876 patent." The court reasoned that an engineer "upon viewing the University of Maryland studies, would have discarded the viability of streamlining the actual body of a tractor-trailer," that "an add-on streamlining device, such as a fairing, . . . would be much more effective," that such a "device was impractical," that the "Stamm patent would have revealed . . . add-on streamlining devices," that "large cumbersome, U-shaped frames [of Stamm] for both the trailer and tractor might well have inspired an inventor to seek a simpler way to reduce air drag," and that "Constantin and the aerodynamic literature would have provided the ideal alternative to reduce drag."

With respect to Constantin, the court said:

> [i]t and the other literature [referring to the scientific articles and textbooks] disclose that a simple blunt-edged deflector placed in front of a large bluff body can reduce drag. The court finds persuasive Dr. Widnall's testimony that the Constantin patent and the "favorable interference" data, combined with the Stamm and the bug deflector patents, would have suggested to an engineer with knowledge of aerodynamic principles the design of a wind-deflecting baffle that could easily be mounted on top of a trailer cab. Together, the references would have suggested the desirability of combining Constantin's theory with Stamm's practical application suggestions.

Although the district court concludes that the combination of these references would suggest the claimed invention, it does not show that there is any teaching or suggestion in any of the references, or in the prior art as a whole, that would lead one with ordinary skill in the art to make the combination. *Interconnect Planning Corp.*, 774 F.2d at 1143, 227 USPQ at 551. The district court makes the combination solely on the basis of its own analysis, aided by Uniroyal's expert.

Constantin apparently places a baffle in front of the vehicle so as to direct the air flow around the entire vehicle. There is no

reason to combine Constantin with the Maryland study and/or Stamm. The Constantin reference is based on the wind resistance principle that a "shield, if placed in front of a large bluff body, will deflect the airstream away from the front of the bluff body thereby reducing the air resistance." Both the Maryland study and Stamm are based on the principle of streamlining, the antithesis of Constantin. In view of the antithetical principles of operation and the absence of any teaching or suggestion to combine these prior art devices, there is no apparent basis for the district court's conclusion that it would have been obvious to one skilled in the art to make the combination. *See In re Sernaker*, 702 F.2d 989, 994, 217 USPQ 1, 5 (Fed. Cir. 1983).

Even if the district court were correct in combining Constantin with Stamm and the Maryland study, the structure created would, in any event, fall short of the invention defined by claims 1 and 2. They require a deflector mounted to extend above the tractor roof, which is inclined in a rearward direction and convex. The structure that might be achieved by the district court's combination would not be so shaped and positioned.

The court considered any differences between the claimed invention and the prior art to be "superficial," primarily because Constantin and the scientific publications[5] teach the "very same [aerodynamic] principle" as utilized in the '876 patent. The mere fact that a device or process utilizes a known scientific principle does not alone make that device or process obvious. *Lindemann Maschinenfabrik GmbH v. American Hoist & Derrick Co.*, 730 F.2d at 1462, 221 USPQ at 489.

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5 The court identified the pertinent publications as follows: a textbook entitled *Fluid Dynamic Drag* published by Hoerner in 1985; a translation of Eiffel's *The Resistance of the Air and Aviation* by Jerome Hunsaker; an article by Hurley entitled "The Use of Boundary Layer Control to Establish Free Stream-line Flows"; *Theory of Flight* by R. Von Mises; and the NACA documents of aero-dynamic experiments from 1920-1960. These articles and textbooks do disclose certain "shielding" principles that can be used to scientifically explain the workings of Saunders' invention. However, there was no showing that any of them contains an example material to the Saunders' invention. The articles and texts merely discuss shielding and streamlining as scientific principles in the theoretical abstract.

Finally, the district court in its validity discussion has erred in other respects. It appears to have applied the often rejected obvious-to-try standard when it says that after combining Constantin, the Maryland study and Stamm, it would be a matter of "experimentation in order to extract the exact parameters [for the height and positioning] that would make the device work." *See, e.g., American Hospital Supply Corp. v. Travenol Laboratories, Inc.*, 745 F.2d 1, 7, 223 USPQ 577, 582 (Fed. Cir. 1984). At the same time, the court states "even an expert would be unable to predict the result an aerodynamic device would have on a tractor-trailer vehicle." This suggests nonobviousness, not routine experimentation.

We also note that the district court relied on similarities between "the U-shaped shells of Stamm which are attached across the top of the cab and extend downward along and connect to the sides of the tractor" and the Saunders configurations depicted in Figures 16 and 17 of the patent. In the specification, Figures 16 and 17 are described as diverting the "flow of air around the sides of the truck" and providing a shield "along each edge of the cab extending downwardly." However, these limitations do not appear in the claims as finally allowed. This court has repeatedly held that it is the claims which define the invention. *Loctite Corp. v. Ultraseal Ltd.*, 781 F.2d 861, 870, 228 USPQ 90, 95 (Fed. Cir. 1985). The district court therefore erred in comparing these specification figures with the prior art to determine the patentability of the invention.

(2) *Secondary Considerations*

Objective evidence of nonobviousness "must always when present be considered en route to a determination of obviousness" because:

> evidence of secondary considerations may often be the most probative and cogent evidence in the record. It may often establish that an invention appearing to have been obvious in light of the prior art was not. It is to be considered as part of all the evidence, not just when the decisionmaker remains in doubt after reviewing the art.

Stratoflex, Inc. v. Aeroquip Corp., 713 F.2d 1530, 1538-39, 218 USPQ 871, 879 (Fed. Cir. 1983). With respect to Rudkin-Wiley's objective evidence of nonobviousness, the district court said that:

> [a]fter acquiring exclusive rights to the '876 patent from Mr. Saunders in 1966, Rudkin-Wiley launched an intensive multi-media promotional campaign using advertising, publicity, personal appearances by Mr. Wiley before the trucking industry, and vigorous sales efforts. No real evidence of the trucking industry's receptiveness to the air deflector manifested for seven years. And then, in 1973, demand for a gas-saving device increased to stave off the effects of the then current oil crises. As such, there is not evidence of long-felt need.

In the district court's view, Rudkin-Wiley's dramatic increase in sales beginning in 1973 was related more to the oil-crisis-induced demand than to any inherent desirability of Saunders' device. Even though demand increased after the oil crisis, the court overlooked the fact that it was the claimed invention to which the industry turned, and it was the uniqueness of the claimed invention which made this so. *See Hybritech Inc. v. Monoclonal Antibodies, Inc.*, 802 F.2d 1367, 1383, 231 USPQ 81, 93 (Fed. Cir. 1986), *cert. denied*, 107 S. Ct. 1606 (1987). As the court found, "it is undeniable that Rudkin-Wiley spawned a multi-million dollar industry with the introduction of a wind-reducing device for tractor-trailer vehicles."

The court also did not take into account other objective evidence of long felt need and failure of others. The Maryland study, by itself, is strong evidence of both. The fact that such an extensive study was performed in 1953 shows a significant interest in drag reduction techniques long before fuel consumption became a critical concern. In addition, the record does not contain any indication that in the approximately ten years between the Maryland study and Saunders' invention any solution to the air resistance problem of tractor-trailers was forthcoming, particularly a solution of such effectiveness, and of such ease of use and manufacture, as the claimed invention.

The district court did not consider the failure of the Maryland study to produce an effective solution to the wind resistance problem as an indication of long felt need. Instead, it viewed that failure as an indication that a later invention, based on a different principle, would have been obvious, because the inventor would know from such failure that he should try some other approach. Under this reasoning, it would be progressively more difficult, after a succession of failures, to secure a patent or an invention that provided a solution to a long felt need. This is contrary to the well established principle that the failure of others to provide a feasible solution to a long standing problem is probative of nonobviousness. *In re Piasecki*, 745 F.2d 1468, 1473-75, 223 USPQ 785, 790 (Fed. Cir. 1984).

In sum, we are convinced that the secondary evidence as a whole strongly suggests the nonobviousness of the claimed invention.

Having carefully reviewed the record, we conclude that the district court impermissibly used a hindsight analysis in determining that the claimed invention would have been obvious and did not properly analyze and consider secondary indicia of nonobviousness. Accordingly, that portion of the judgment holding that the '876 patent is invalid is reversed.

B. *Infringement*

(1) *Literal Infringement*

Literal infringement requires that every limitation of the patent claim must be found in the accused device. *Mannesmann Demag Corp. v. Engineered Metal Products Co.*, 793 F.2d 1279, 1282, 230 USPQ 45, 46 (Fed. Cir. 1986). The party alleging infringement, in this case Rudkin-Wiley, has the burden of proving infringement by a preponderance of the evidence. *Hughes Aircraft Co. v. United States*, 717 F.2d 1351, 1361, 219 USPQ 473, 480 (Fed. Cir. 1983). "Analysis of patent infringement involves two inquiries: determination of the scope of the claims . . . followed by determination of whether properly interpreted claims encompass the accused structure." *Mannesmann Demag Corp. v. Engineered Metal Products Co.*, 793 F.2d at 1282, 230 USPQ at 46.

"Claim construction is reviewed as a matter of law. *Fromson v. Advance Offset Plate, Inc.*, 720 F.2d 1565, 1569, 219 USPQ 1137, 1140 (Fed. Cir. 1983). However, interpretation of a claim may depend on evidentiary material about which there is a factual dispute, requiring resolution of factual issues as a basis for interpretation of the claim. *See Moeller v. Ionetics, Inc.*, 794 F.2d 653, 656, 229 USPQ 992, 995 (Fed. Cir. 1986); *Palumbo v. Don-Joy Co.*, 762 F.2d 969, 974, 226 USPQ 5, 8 (Fed. Cir. 1985)." *H.H. Robertson Co. v. United Steel Deck, Inc.*, 820 F.2d 384, 389, 2 USPQ2d 1926, 1929 (Fed. Cir. 1987). The question of literal infringement (do the claims read on the accused device) is determined as a factual inquiry and is reviewed on a clearly erroneous standard. *Loctite Corp. v. Ultraseal Ltd.*, 781 F.2d at 866, 228 USPQ at 93.

(a) *Claim 2*

It is established in patent law that "[w]here some claims are broad and others narrow, the narrow claim limitations cannot be read into the broad whether to avoid invalidity or to escape infringement." *D.M.I., Inc. v. Deere & Co.*, 755 F.2d 1570, 1574, 225 USPQ 236, 239 (quoting *Deere & Co. v. Int'l Harvester Co.*, 658 F.2d 1137, 1141, 211 USPQ 11, 16 (7th Cir.), *cert. denied*, 454 U.S. 969 (1981)). The district court erred as a matter of law in not following this well recognized principle when it interpreted claim 2.

In determining the absence of literal infringement, the court construed claims 1 and 2 together and read them as if they both contained the same limitations. It held that claims 1 and 2 required an "airflow deflecting baffle" which worked by "diverting the airflow relatively widely" and which created a "low pressure air eddy" in the gap between the cab and the trailer. It found the Uniroyal device did not literally infringe because it more resembled a fairing than a shield or baffle in that it "emphasizes smooth contours and attached flow." The recitations of diverting airflow relatively widely and creating a low pressure air eddy, however, are found only in claim 1 and not in claim 2.

Uniroyal contends that the district court's statement that the Uniroyal device works much more like a fairing should be taken as a finding of no literal infringement because the specification makes clear that Saunders meant to cover only baffle-type deflectors and not fairing-type deflectors. However, this argument is not persuasive because claim 2 contains no limitation concerning "working more like a shield [or baffle] than a fairing," and it is the language of the properly interpreted claims which determines infringement. *Kalman v. Kimberly-Clark Corp.*, 713 F.2d 760, 770-71, 218 USPQ 781, 788 (Fed. Cir. 1983), *cert. denied*, 465 U.S. 1026, 224 USPQ 520 (1984).

Uniroyal's device is undeniably "a baffle mounted to extend above the tractor cab roof" and "vertically inclined rearwardly and forwardly convexed in a horizontal plane." Therefore, these limitations of claim 2 (*see* paragraphs (a) and (b) of claim 2, *supra* at page 3) are met by Uniroyal's device. Moreover, these limitations do not exclude deflectors also convexed vertically in the manner of Uniroyal's deflector. With respect to the height limitation of paragraph (c) and the position limitation of paragraph (d), the district court declined to consider them, stating:

> The fact that optimal placement of the '876 baffle may coincide in some instances with optimal placement of the Uniroyal device does not demonstrate that the Uniroyal device infringes upon the '876 formulae. The '876 claims cannot be viewed as claiming specific locations for an air deflector, but rather as formulae for determining optimal height and location of the deflector.

This was error on the part of the district court. Since limitations (a) and (b) are satisfied, if the height and position of the Uniroyal devices are within limitations (c) and (d), the claims are infringed and this is the end of the inquiry. It was apparently established[6] that the Uniroyal devices, at least in some in-

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6 See, for example, footnote 6 of the district court's opinion, stating in pertinent part:

> The Uniroyal deflector is a standard height and Uniroyal advises its customers to mount the deflector at the rear of the cab. The slope of

stances, fall within the scope of these limitations. We note that the height and position limitation in the claim are modified by the terms "substantially" and "approximately." These terms must be interpreted in light of the specification and prosecution history to determine the literal coverage of the claims with respect to height and position. That part of the judgment holding that claim 2 is not literally infringed is, therefore, reversed. The extent of literal infringement must be ascertained on remand by determining the accused devices that meet the height and positioning parameters of claim 2. *See supra*, note 6.

(b) *Claim 1*

The district court found that claim 1 of the '876 patent is not infringed because the Uniroyal device does not function in the manner required by the claim, i.e., by "diverting the air flow relatively widely" and by creating a "low pressure air eddy" in the "gap between the tractor and the trailer."

The court explained its finding that the Uniroyal device does not divert the air flow relatively widely as follows:

> The inventor of the Uniroyal deflector . . . designed his . . . device as a continuously curved shape that would di-

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the deflector is adjustable, varying with the height of the trailer and the distance between the trailer and the cab. The optimal slope is a function of the ratio between the height differential and the gap distance. Therefore, rather than varying two parameters according to a constant determined ratio, as in the '876 patent, the Uniroyal device varies one parameter according to a variable ratio.

Rudkin-Wiley argues that the effect of the Uniroyal size and placement is to fall within the parameters set forth in its claims. It arrives at its conclusion by noting that trailers have a standard width of 96 inches, giving a half width of 48 inches, and will usually be located between 24 and 60 inches from the back of the cab. Applying its fixed ratios to these distances gives height and location parameters which include the usual placement and height of a Uniroyal deflector.

. . .

The fact that optimal placement of the '876 baffle may coincide in some instances with optimal placement of the Uniroyal device does not demonstrate that the Uniroyal device infringes upon the '876 formulae.

> rect the airflow with a minimum of separation directly to the desired parts of reattachment. . . . Unlike the '876 patent the . . . [Uniroyal] device emphasizes smooth contours and attached flow. . . . The . . . [Uniroyal] device thus operates on an aerodynamic principle more similar to a fairing than a deflecting baffle. Therefore, there is no literal infringement of the claim regarding a baffle that diverts the airflow widely.

Terms of a claim must be interpreted with regard to the other claims, the specification and the prosecution history. *Fromson*, 720 F.2d at 1569-71, 219 USPQ at 1140-41; *Loctite Corp.*, 781 F.2d at 866, 228 USPQ at 93. The specification of the '876 patent explains that "rather than streamlining the vehicle body . . . the device of the instant invention produces a relatively wide diffusion of the air impacting the forward portion of the trailer, and causes the same to readhere to the body of the truck rearwardly of the front portion thereof in a relatively smooth and even manner. . . ." Thus, "diverting the airflow relatively widely" means diverting the airflow so that it does not impinge upon the front of the trailer. Although the district court emphasized that the Uniroyal device was more "streamlined and acted much like a fairing" to allow the air flow to leave the trailing edge of the device smoothly, it also determined that the direction of the air flow was changed "so as to flow onto the leading edges of the trailer." The Uniroyal device therefore diverts the airflow relatively widely in the manner that the properly construed claim requires.

The district court was erroneous in finding the Uniroyal device did not create a low pressure air eddy in the "gap" in Uniroyal as required by claim 1. The record shows that Dr. Widnall, who was a witness for Uniroyal, testified that "there was an eddy behind the deflector" but that she "did not take any pressure measurements." Her opinion was that "the pressure behind that deflector would be lower than atmospheric." The question then is whether "gap" as used in the claim includes the area behind the deflector above the roof of the tractor cab. The illustrations and descriptions in the specification

indicate that the air eddy and gap can be above the cab roof. In the light of the specification, the district court unduly restricted the scope of the claim in construing "gap" to mean only the space from the rear of the tractor cab to the front of the trailer.

Accordingly, claim 1 is literally infringed. That part of the judgment holding that claim 1 is not literally infringed is, therefore, reversed and the case is remanded to determine the extent of literal infringment of claim 1. *See supra*, note 6.

(b) *Claims 3 and 4*

The district court found that claim 3 and dependent claim 4 are not infringed because the Uniroyal device does not have a lower edge in a substantially air impervious relationship with the cab roof as required by claim 3. There was extensive evidence regarding the configuration and operation of the Uniroyal device and the construction of claims 3 and 4, including the testimony of experts on both sides. We are not persuaded that the district court's findings with respect to literal infringement of these claims are clearly erroneous. *Loctite Corp.*, 781 F.2d at 866, 228 USPQ at 93. Nor can we say that the court's construction of these claims was wrong as a matter of law. *Fromson*, 720 F.2d at 1569, 219 USPQ at 1140.

Accordingly, we affirm that part of the district court's judgment holding that claims 3 and 4 were not literally infringed.

(2) *Infringement under the Doctrine of Equivalents*

The district court properly recognized that when literal infringement is not found the equitable doctrine of equivalents may come into play. Thus, if there are Uniroyal devices that do not literally infringe, infringement under the doctrine of equivalents must be considered. Under the three pronged analysis from *Graver Tank & Mfg. Co. v. Linde Air Products Co.*, 339 U.S. 605, 608-09 (1950), infringement under the doctrine depends on whether the accused device performs substantially the same function, in substantially the same way to achieve the same result.

Rudkin-Wiley urges this court to hold that the patented invention is infringed under the doctrine of equivalents as a mat-

ter of law. This we decline to do. Whether a device is equivalent to a claimed invention is a factual inquiry. *Raytheon Co. v. Roper Corp.*, 724 F.2d 951, 961, 220 USPQ 592, 600 (Fed. Cir. 1983), *cert. denied*, 469 U.S. 835, 225 USPQ 232 (1984). Because the district court did not consider infringement under the doctrine of equivalents in the light of properly construed claims and because of errors made by the district court in applying the doctrine of equivalents, this issue must be remanded for factual determinations.

In the doctrine of equivalents section of its opinion, the court discussed the height and distance parameters of the claims and stated that:

> Even if the installation of Uniroyal's device results in literally duplicating the distance and height requirements of the '876 patent, there is no infringement *because Uniroyal does not rely on those specific parameters to mount its deflector*. . . . The Uniroyal deflector, therefore, does not infringe upon the dimensional or positioning claims in the '876 patent. (Emphasis added.)

If the installation of Uniroyal's device duplicates the distance and height parameters of the claims of the '876 patent, assuming the other claim limitations are also met, there would, contrary to the court's conclusion, be literal infringement. Whether or not Uniroyal has relied on the parameters in the claims is irrelevant if its device in fact falls within those limitations. Similarly, in a doctrine of equivalents analysis, if it is established that Uniroyal does not rely on the claimed height and positioning parameters, that does not, standing alone, demonstrate absence of infringement. Only if this fact shows that Uniroyal's device does not perform *in substantially the same manner* would it be probative of no infringement under the doctrine and the court should make this determination on remand. As noted, the other two aspects of the doctrine (function and result) were satisfied.

Finally, the district court erred in finding Uniroyal's improvement over the claimed invention to be a distinguishing feature. The district court said "the device differed from the

'876 patent in that it was designed to be an adjustable deflector" and concluded that this was another reason it was noninfringing under the doctrine of equivalents. Adding features to an accused device will not result in noninfringement if all the limitations in the claims, or equivalents thereof, are present in the accused device. *Amstar Corp. v. Envirotech Corp.*, 730 F.2d 1476, 1482, 221 USPQ 649, 653 (Fed. Cir.), *cert. denied*, 469 U.S. 924, 224 USPQ 616 (1984) ("[M]odification by mere addition of elements or functions . . . cannot negate infringement").

CONCLUSION

The portion of the judgment holding the '876 patent to be invalid under section 103 for obviousness is reversed. The portion of the judgment that claims 1 and 2 of the '876 patent are not literally infringed is reversed and that claims 3 and 4 are not literally infringed is affirmed. The portion of the judgment that the claims are not infringed under the doctrine of equivalents is vacated. The case is remanded to the district court for further proceedings consistent with this opinion.

AFFIRMED-IN-PART, REVERSED-IN-PART, VACATED-IN-PART AND REMANDED

APPENDIX

1. In combination with a tractor-trailer vehicle having a gap between the tractor and the trailer, said tractor being of less height than said trailer, an airflow deflecting baffle mounted to extend above the cab roof of said tractor for diverting the air flow relatively widely in a manner to avoid entry of the air stream into said gap thereby creating at least one low pressure air eddy in said gap to reduce the frontal air pressure against the trailer, said diverted air reattaching to the trailer at points

spaced rearwardly of said gap, said baffle being inclined vertically rearwardly and forwardly convexed in a horizontal plane, positioned a distance from the front of the trailer equal to approximately 0.7 the half width of the trailer end of a height substantially 0.7 of the difference in height between the tractor cab roof and the roof of the trailer.

2. In combination with a tractor-trailer vehicle having a gap between the tractor and the trailer, an air flow deflecting shield comprising a baffle mounted to extend above the tractor cab roof, said baffle being vertically inclined rearwardly and forwardly convexed in a horizontal plane, said baffle having a predetermined height substantially 0.7 of the difference in height between said cab roof and the trailer roof, said baffle being positioned a distance from the front of the trailer equal to approximately 0.7 the half width of the trailer.

3. In combination with a tractor-trailer vehicle having a gap between the tractor and the trailer, said tractor having a cab with the roof thereof of less height than said trailer, a substantially solid upstanding air flow deflecting baffle mounted to extend above the cab roof and having its lower edge in substantially air impervious relation therewith, for diverting the substantially entire air flow relatively widely in a manner to avoid entry of the air stream into the gap, thereby creating at least one low pressure air eddy in said gap to reduce the frontal air pressure against the trailer, the diverted air reattaching to the trailer at points spaced rearwardly of said gap, said baffle being of a height between 0.5 and 0.9 of the difference in height between the tractor cab roof and the roof of the trailer, and being positioned a distance from the front of the trailer equal to between 0.3 and 2.0 times the half width of the trailer.

4. The structure of claim 3 wherein said baffle is positioned immediately adjacent the rear of the cab roof.

District Court Decision

UNITED STATES DISTRICT COURT
DISTRICT OF CONNECTICUT

Civil No. N-75-51 (EBB)

UNIROYAL, INC.

v.

RUDKIN-WILEY CORPORATION

Civil No. B-80-281 (EBB)

PREMIX, INC.

v.

RUDKIN-WILEY CORPORATION

MEMORANDUM OF DECISION

1. *Background*

The plaintiffs in these actions, Uniroyal, Inc., and Premix, Inc., seek a declaratory judgment that U.S. Patent 3,241,876 (the " '876 patent") is invalid. The '876 patent, relating to an air deflector for tractor-trailer vehicles, was designed by and issued to W. D. Saunders, a Massachusetts Institute of Technology graduate and inventor, but was later assigned to the defendant, Rudkin-Wiley Corporation, which acquired exclusive licensing rights in 1966. Rudkin-Wiley filed a counterclaim against the plaintiffs in which it seeks a declaration that the drag-reducing device sold by Uniroyal and Premix ("The

Uniroyal device or deflector") infringes upon the '876 patent, together with damages for such infringement. The actions brought by the plaintiffs were consolidated for trial. The court finds the '876 patent to be invalid and not infringed.

The '876 patent is a device designed to address the problem of wind resistance encountered by a tractor-trailer vehicle travelling at high speed when the blunt face of the trailer, which is usually higher than the tractor, is exposed to the oncoming wind. Aerodynamic forces coming in contact with such a bluff body result in air turbulence in the gap between the tractor and trailer, and a rearward directed pressure against the exposed portion of the trailer. These forces hinder the truck's forward movement in what is described as an "aerodynamic drag." The drag reduces efficiency and therefore leads to increased costs for additional fuel needed to overcome the drag.

The '876 patent discloses a device that is attached to the roof of the tractor cab in order to deflect the oncoming wind away from the face of the trailer. This patent was based on a previous application filed in 1964, serial number 341,622 ("622"). The '622 patent application was a continuation-in-part of U.S. Patent Application No. 215,424, which was filed in 1962, rejected, and abandoned after the filing of the '622 application. The '876 patent, acquired in 1966, described as an "Apparatus for reducing linear and lateral wind resistance in a tractor trailer combination vehicle", expired on March 22, 1983.

The patent contains four claims,[1] which describe a "substantially solid upstanding" airflow deflecting baffle that is "verti-

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1 Claims:

1. In combination with a tractor-trailer vehicle having a gap between the tractor and the trailer, said tractor being of less height than said trailer, an airflow deflecting baffle mounted to extend above the cab roof of said tractor for diverting the airflow relatively widely in a manner to avoid entry of the air stream into said gap thereby creating at least one low pressure air eddy in said gap to reduce the frontal air pressure against the trailer, said diverted air reattaching to the trailer at points spaced rearwardly of said gap, said baffle being inclined vertically rearwardly and forwardly convexed in a horizontal plane posi-

cally inclined rearwardly and forwardly convexed in a horizontal plane". The baffle is mounted on the cab roof, positioned a distance from the front of the trailer equal to "approximately 0.7 the half width of the trailer and of a height substantially 0.7 of the difference in height between the tractor cab roof and the roof of the trailer." It is mounted with its "lower edge in substantially air impervious relation" to the cab roof in order to curtail the airflow from entering the gap between the tractor and trailer. The curtailment of the entry of the airflow creates "at least one low pressure air eddy in said gap to reduce the frontal pressure against the trailer." The baffle is designed to divert the airflow "relatively widely in a manner to avoid entry of the airstream into [the] gap" so that frontal pressure will be

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tioned a distance from the front of the trailer equal to approximately 0.7 the half width of the trailer and of a height substantially 0.7 of the difference in height between the tractor cab roof and the roof of the trailer.

2. In combination with a tractor-trailer vehicle having a gap between the tractor and the trailer, an airflow deflecting shield comprising a baffle mounted to extend above the tractor cab roof, said baffle being vertically inclined rearwardly and forwardly convexed in a horizontal plane, said baffle having a predetermined height substantially 0.7 of the difference in height between said cab roof and the trailer roof, said baffle being positioned a distance from the front of the trailer equal to approximately 0.7 the half width of the trailer.

3. In combination with a tractor-trailer vehicle having a gap between the tractor and the trailer, said tractor having a cab with the roof thereof of less height than said trailer, a substantially solid upstanding air flow deflecting baffle mounted to extend above the cab roof and having its lower edge in substantially air impervious relation therewith, for diverting the substantially entire air flow relatively widely in a manner to avoid entry of the air stream into the gap, thereby creating at least one low pressure air eddy in said gap to reduce the frontal air pressure against the trailer, the diverted air reattaching to the trailer at points spaced rearwardly of said gap, said baffle being of a height between 0.5 and 0.9 of the difference in height between the tractor cab roof and the roof of the trailer and being positioned a distance from the front of the trailer equal to between 0.3 and 2.0 times the half width of the trailer.

4. The structure of claim 3 wherein said baffle is positioned immediately adjacent the rear of the cab roof.

reduced and air will be diverted convexly across the gap and over and around the trailer where it will then reattach smoothly at the sides and top of the trailer. In this way, the '876 baffle manages to intercept the airflow that would ordinarily hit the exposed portion of the trailer.

Both parties introduced experts to explain the various inventions at issue. The plaintiffs presented Dr. Sheila Widnall, a professor of aeronautics at the Massachusetts Institute of Technology. The defendant produced Dr. Frank Buckley, a professor of mechanical engineering at the University of Maryland. Both experts were helpful in illuminating what often proved to be highly technical subject matter. The court was especially impressed with Dr. Widnall, whose comprehensive testimony was not only highly elucidating and thorough, but was at all times consistent.

II. *Validity*

Once an application for a patent is accepted by the Patent and Trademark Office ("PTO"), a strong presumption of validity attaches to the issued patent. "A patent shall be presumed valid. Each claim of a patent (whether in independent, dependent, or multiple dependent form) shall be presumed valid independently of the validity of other claims. . . . The burden of establishing invalidity of a patent or any claim thereof shall rest on the party asserting such invalidity." 35 U.S.C. § 282. This presumption is rebutted only with evidence meeting the clear and convincing standard. *American Hoist & Derrick Co. v. Sowa & Sons, Inc.*, 725 F.2d 1350, 1360 (Fed. Cir. 1984), *cert. denied*, 105 S. Ct. 95 (1984). The burden of proof is not weakened or waived even where the attacker can present prior art not considered by the PTO examiner. *Connell v. Sears Roebuck and Co.*, 722 F.2d 1542, 1549 (Fed. Cir. 1983). However, when prior art exists that was not considered by the examiner, because there is no PTO view on whether the reference would have made the patent obvious, plaintiff's burden of proof is more easily carried. *EWP Corp. v. Reliance Universal Inc.*, 755 F.2d 898, 905 (Fed. Cir. 1985); *American Hoist & Derrick Co. v. Sowa & Sons, Inc.*, *supra*, at 1359. This is true only where the

prior art is more pertinent than those references already considered by the examiner. *Connell v. Sears Roebuck Co., supra*, at 1549.

The issue of the validity of the '876 patent was previously presented to the District Court for the Northern District of Indiana which ruled that the patent was invalid. *See Saunders v. Air-Flow Co.*, 435 F. Supp. 298 (N.D. Ind. 1977). That decision was overruled and the '876 patent held valid by the Seventh Circuit in *Saunders v. Air-Flo*, 646 F.2d 1201 (7th Cir. 1981). The doctrine of *stare decisis* may be inapplicable in patent litigation. While some weight should be given to a prior suit on the issue of validity, "the weight given a prior holding of 'validity' will vary depending on the additional prior art or other evidence on patentability that is provided in the subsequent suit." *Stevenson v. Sears Roebuck & Co.*, 713 F.2d 705, 711, n. 5 (Fed. Cir. 1983); cited with approval in *Shelcore, Inc. v. Durham Industries, Inc.*, 745 F.2d 621, 627, n. 10 (Fed. Cir. 1984). A prior holding whose record is "substantially identical" to the record in the second suit should be given *stare decisis* effect. *Stevenson, supra*. Uniroyal has brought forth a 1913 Austrian patent, Patent No. 62,329 (the "Constantin patent") as prior art not considered by the PTO examiner in evaluating the validity of the '876 patent. Although Rudkin-Wiley asserts that this prior art was considered by the Seventh Circuit in *Saunders v. Air-Flo, supra*, the court finds that the complete absence of discussion or mention of the Constantin patent in both the trial and appeal decisions of *Saunders*, coupled with Rudkin-Wiley's failure to substantiate its claim, indicates that the Constantin patent was never given serious attention as prior art. Therefore, a *stare decisis* effect on the holding of *Saunders v. Air-Flo* would be inappropriate since the record in that case was substantively different from the case at bar.

A. *Anticipation*

"Anticipation requires the presence in a single prior art disclosure of all elements of a claimed invention arranged as in the claim." *Connell v. Sears, Roebuck & Co.*, 722 F.2d 1542, 1548 (Fed. Cir. 1983). It is not enough to show that the prior art dis-

closes almost all the elements so as to allow one of ordinary skill to complete the work for the invention. *Id.* The elements of the claimed patent must be shown to have corresponding elements disclosed in a single anticipatory reference. *Lindemann Maschinenfabrik v. Am. Hoist and Derrick*, 730 F.2d 1452 (Fed. Cir. 1984). At the outset, plaintiffs have presented two references as prior art which they claim anticipate the Saunders patent. Because there can be no combination disclosures, each reference must be viewed separately.

The prior references are two sets of photographs. The first set of photographs, Exhs. 66 and 91, are photocopies of magazine advertisements that appeared in a 1961 issue of *Commercial Motor* and a 1962 issue of *Commercial Vehicle*. The advertisements contain a photograph of a tractor-trailer combination having an upright thin shield mounted on top of the cab of the tractor. Plaintiffs' expert, Dr. Widnall, testified that, if the device on top of the truck had adequate structural capability, it would function exactly as the air deflecting baffle described in the '876 patent. Tr. 1140. This conclusion was based on the fact that the shield displaced a very abrupt surface such that airflow would be widely deflected upon contact with the device. In addition, the shield was consistent with a "vertically inclined rearwardly convexed shape" and seemed to have a gap between the tractor and trailer. Tr. 1141. Dr. Widnall opined that the positioning of the baffle seemed to follow the .7 ratios claimed in the '876 patent but conceded that she could not "tell by just looking at the drawing." Tr. 1142.

In the second set of photographs submitted by plaintiffs, an early model of an old-fashioned truck with an open trailer is depicted. It too, has a flat-plated shield on top of its tractor cab. The shield bears the insignia "P.A.X." as does a metal sign located on the side of the trailer. The initials stand for the Penninsula Auto Express Company which is also printed on the sign located on the side of the trailer.

An anticipatory reference must be a "printed publication." 35 U.S.C. § 102. It is plaintiffs' burden to demonstrate that the references declared to be anticipatory are "available and accessible to persons concerned with the art to which the document

relates and thus most likely to avail themselves of its contents." *In re Wyer*, 655 F.2d 221, 227 (CCPA 1981), *citing with approval, Philips Electronics and Pharmaceutical Industries Corp. v. Thermal and Electronic Industries, Inc.*, 450 F.2d 1164, 1171 (3rd Cir. 1971).

The plaintiffs presented evidence that the photograph was filed with American Commercial Photo Company in Detroit, Michigan. Commercial Photo Company handles accounts for makers of machines and tools, and trucking companies. Tr. 230. The photographs are filed by date and company's name. There is no accompanying description of the object itself. Tr. 238. The specific photo in question was filed for the Fruehauf Company—a company that stores pictures of trucks for advertising and research and development purposes. An expert in the area of transportation trucking and the history of old trucks, who is also a collector of photographs of old trucks, Donald F. Wood, testified that he had received a copy of the P.A.X. truck photograph by contacting the public relations department of Fruehauf in Detroit. Tr. 259-260. As a researcher and hobbyist of old trucks, he testified that he believed that the files of truck manufacturers were an "ordinary, customary source of information for a researcher in this area." Tr. 2557.

Neither the United States Court of Customs and Patent Appeals nor the Federal Circuit has passed on the question of whether a photograph constitutes a "printed publication" under Section 102. The court in *Universal Athletic Sales Co. v. American Gym, Inc.*, 546 F.2d 530, 543 (3rd Cir. 1976) found that a photograph could anticipate a claimed patent if "one conversant in a pertinent art could make or construct a purported invention without resorting either to the patent or to his own inventive skills." Certainly this view is not inconsistent with that of the Court of Customs and Patent Appeals, which has adopted a unitary concept of a "printed publication." In *In re Wyer*, 655 F.2d 221, 225-27 (CCPA 1981), the court recognized that, with the advanced state of technology, there are no longer valid reasons for maintaining the traditional dichotomy between "printing" and "publishing," and limited inquiry to the single touchstone question of the document's "public acces-

sibility". Under this view, a photograph can constitute a suitable printed publication if it is accessible. Access is to be determined on a case by case basis using such factors as classification and indexing. *Wyer*, at 226-7.

The testimony of plaintiffs witness, Mr. Wood, revealed that the P.A.X. photo was not indexed by topic either in the Fruehauf files or the Commercial Photo files; but, instead, was indexed by date and company. This classification system is similar to that found in the *Application of Bayer*, 568 F.2d 1357 (CCPA 1978). In that case, the court decided that a graduate thesis was not a "printed publication" where it could only be located in a university library by one informed of its existence and not by the customary means of research aids available in the library. *Bayer*, at 1361. The court finds that, contrary to Mr. Wood's testimony, the availability of the P.A.X. photograph was not such that an interested person with ordinary skill in the art would be able to locate the photograph even if "exercising reasonable diligence." *Wyer*, at 226.

Even were the P.A.X. photographs found to constitute "printed publications", neither they nor the photos in Exhs. 61 and 91, *supra*, anticipate the '876 patent. The shields in both sets of photographs are evidently signboards intended to advertise a product, and not a wind deflecting baffle. The flimsiness of the shields belies their structural capability as a baffle. It is well-settled that when prior art accidentally and unwittingly duplicates the claimed invention with no recognition of the true application that the claimed invention has uncovered, there is no anticipation. *Silvestri v. Grant*, 496 F.2d 593, 597 (CCPA 1974) ("an accidental or unappreciated duplication of an invention does not defeat the patent right of one who, though later in time, was the first to recognize that which constitutes the inventive subject matter."); *Application of Marshall*, 578 F.2d 301, 304 (CCPA 1978).

Furthermore, it is evident that not all the claims of the '876 patent are disclosed in each set of photographs. Without more evidence, it is impossible to assess whether the shields were positioned and of a height to satisfy the .7 ratios of the claimed invention. Nor can it be determined if the airflow would form an

eddy in the gap between the tractor and trailer. Because the presence in either prior reference of each and every element of the '876 patent is not disclosed, neither of the sets of photographs anticipates the '876 patent. *Lindemann Maschinenfabrik, supra*, at 1458.

B. *Obviousness*

A patent is invalid where "the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art." 35 U.S.C. 103. The issue of obviousness is a question of law to be determined by an analysis of three factual questions: (1) the scope and content of prior art; (2) the differences between the prior art and the claims at issue; and (3) the level of ordinary skill in the pertinent art. In addition, the court should examine the "real life" factors surrounding the patent's development; these "secondary considerations" include the level of commercial success attained by the patent, unexpected results, and a long-felt need for the patent's utility. *Graham v. John Deere Co.*, 383 U.S. 1, 17 (1965).

1. *Scope and Content of Prior Art*

Prior art is to be determined by looking at the problem to be solved by the inventor. *Union Carbide Corp. v. American Can Co.*, 724 F.2d 1567, 1572 (Fed. Cir. 1984). If the prior art is within the field of the inventor's endeavor, the inventor will be presumed to have full knowledge of its contents. If the prior art is outside the field of his endeavor, it must then be determined whether the reference is reasonably pertinent to the particular problem. *Id.* The defendant argued for limiting the scope of prior art to references relating only to tractor-trailer combinations. This scope is too narrow. As Dr. Widnall testified, the problem of producing a baffle for a moving vehicle such as a tractor-trailer vehicle requires wider knowledge. An inventor during 1962-1964 would have looked toward aerodynamic or fluid mechanic solutions to the problem faced by objects having to move through and resist fluid. Tr. 503. The court finds this

testimony persuasive and, accordingly, the following references are well within the realm of prior art.

In 1953, the Wind Tunnel Operations Department of the University of Maryland conducted over 7,000 wind tunnel tests of models of Trailmobile trailers in an attempt to explore methods of drag reduction. All of the experiments used conventional streamlining techniques to reduce drag. In a major test conducted by the university, a smooth contoured surface, or fairing, was placed over the entire gap between the tractor and trailer. The fairing was found to be an ideal alternative to the usual streamlining methods which reshaped the contours of the actual tractor body. The fairing allowed the airflow to remain attached, thereby avoiding air turbulence, while simultaneously drawing the airflow upwards and over the trailer in an attached flow. The study concluded, however, that the fairing was an impractical add-on streamlining device since it interfered with the tractor-trailer unit's ability to turn.

The Maryland studies were not directly cited by the PTO, but were discussed in the Stamm patent, which was cited.

The Stamm patent, No. 2,863,695, was issued on December 9, 1958. The patent states as its objective the provision of a solution to the problem of air drag in tractor-trailer combinations using the findings of the University of Maryland tests. The Stamm patent discloses several add-on airflow control attachments, or U-shaped conduits, mounted on both sides of the rearward portion of the tractor and the forward portion of the trailer. The function of the conduits is described as follows:

> The cab conduit or shell member will cause airstream flow along the top and sides of the cab to be directed rearwardly in such a fashion that it will be directed into the trailer mounted conduit shell member and thereafter discharged along the top and sides of the trailer body in a fashion that tends to reduce airstream turbulence and thereby reduce drag losses. Exh. 36, col. 4, lines 23-30.

Stamm essentially is an alternative to using a device that is contiguously connected to the tractor and trailer, such as the fairing that was used in the Maryland test. Instead, it discloses

the feasibility of attaching separate airflow control attachments to the tractor and trailer in order to direct the airflow away from and over the trailer.

There is no evidence that the Stamm patent was ever commercially reproduced.

Other prior art references introduced at trial included the Davisson patent, U.S. Patent No. 2,236,846, and the Gracey patent, Patent No. 2,184,798, both bug deflector shields for an automobile windshield. Although there was insufficient evidence that these bug deflecting shields reduced drag, they are pertinent in that they illustrate a means by which a deflecting shield may be placed.

An Austrian patent No. 62,329, issued November 25, 1913, to Lewis Constantin of Paris, France (the "Constantin patent"), discloses a device that is attached to vehicles with large carrying capacities in order to reduce the resistance to motion. Constantin teaches the following:

> [I]f one attaches at a suitable distance ahead of the vehicle a shield of suitably shaped cross-section that is smaller than that of the front of the car, the layers of the medium that are deflected by this screen will remove out of the path of the car also other layers that, without the shield, would have struck the vehicle and provided resistance to the motion. It can thus be seen that the vehicle will in this case not have to overcome the resistance of a column of the medium that has the same diameter as its front part, but only that of a column of the diameter of the shield. Accordingly, there will occur a reduction of the resistance. It follows furthermore that this reduction will be that much more substantial the smaller the resistance upon the forward motion of the shield itself, of course, insofar as the capacity of lateral deflection of the latter does not appear to be reduced thereby.
>
> The invention is based on the fact that the thin layers of the medium that are laterally displaced by a body in motion continue to remain deflected over a certain distance, even after they are no longer in contact with the said body,

and that, in this deflection, they carry along the medium layers they encounter.

The Constantin patent was not cited by the Examiner, nor was it considered by the Seventh Circuit in *Saunders v. Air-Flo, supra.*

Several publications similarly discuss the aerodynamic occurrences associated with airflow resistance: A textbook entitled *Fluid Dynamic Drag* published by Hoerner in 1958; a translation of Eiffel's *The Resistance of Air and Aviation* by Jerome Hunsaker; an article by Hurley entitled "The Use of Boundary Layer Control to Establish Free Streamlined Flows"; Von Mises, *Theory of Flight*; and the NACA documents of aerodynamic experiments from 1920-1960.

2. *Differences Between the Prior Art and Claims at Issue*

The Stamm patent is a drag reduction device for a tractor-trailer combination that utilizes U-shaped conduits to achieve a streamlining effect. Mounted on the top edges of both the tractor and the trailer, the conduits guide the airstream toward the top and side peripheral portions of the front end of the trailer.

In his abandoned patent application of 1962, Saunders had originally conceived of a drag reduction device very similar to the Stamm patent. The patent consisted of three vanes mounted on the front and back of the tractor cab and the lower edge of the trailer. These vanes incorporated Stamm's concept of directing the airstream from the cab of the tractor over the gap between the trailer and tractor to the top of the trailer. The only difference was that the Saunders patent contained more vanes and placed the main device in front of the cab whereas the Stamm patent placed it in the rear. Tr. 1053. By the time his '876 patent was approved in 1966, Saunders had altered his design considerably. The vanes were replaced by a flat-plated baffle mounted on the top of a cab roof in a mathematically calculated location. The '876 patent now differed aerodynamically from the Stamm patent in that it used a widely deflecting shield instead of vanes to reduce drag. Whereas vanes make a

small disturbance in the airflow by leading the air from an initial direction to a final direction by means of a curvature, shields make an abrupt change in the flow direction by use of a vertical flat plate or disc. This distinction is noted in the patent itself: "The conventional streamlining techniques heretofore applied have attempted to minimize the forward separation of air by either rounding the forward corners of the truck, employing streamlining vanes or guide vanes to keep the air separation to a minimum, or enclosing the tractor-trailer gap with some form of fairing. The instant invention . . . differs from the above in that there is employed a deflecting device mounted on the tractor which deflects the onrushing air in such a manner as to occasion a very large separation of the airflow." Exh. 158, Col. 1, lines 59-72.

Even though the aerodynamic principles differ, the embodiments shown in the '876 patent reveal certain features remarkably similar to the Stamm patent. In Figures 16 and 17 of the '876 patent, the shield on top of the tractor cab extends downwardly across the sides of the tractor. This modification of the patent, to be used when the tractor is narrower than the trailer, is similar to the U-shaped shells of Stamm which are attached across the top of the cab and extend downward along and connect to the sides of the tractor. More significantly, the '876 patent specifications employ vanes in several of the preferred embodiments. In Figure 21, a box containing parallel vanes is attached to the shield in order to be able to decrease the size of the deflector; in Figure 22, a vane is suggested as an alternative deflector, to be attached to a box-like structure, such as an air conditioner, which out of necessity provides the only baffle on top of the cab. In Figure 15, a small baffle is placed on the forward part of the cab roof with a slot, much like a vane, below it. The slot allows airflow to enter in order to decrease the air pressure between the tractor and trailer.

The Constantin patent is concerned with providing an alternative method to reduce drag for vehicles with large carrying capacities from that normally employed by streamlining devices. Constantin recognizes that streamlining methods, which endow a large carrying capacity vehicle with a tapered shape,

increase the vehicle's deadweight and decrease the vehicle's relative carrying capacity. In addition, streamlining devices are impractical since they often require rebuilding of the existing vehicles. Constantin seeks to remedy these deficiencies.

The Constantin patent shows that a flat-plated shield, if placed in front of a larger bluff body, will deflect the air stream away from the front of the bluff body thereby reducing the air resistance. Admittedly, the Constantin patent lacks the sophistication of design that attends most contemporary patents. It is not concerned with tractor-trailers nor does it reveal information regarding the deflector that is present in the '876 patent: the size, positioning and placement of the deflector. In fact, it seemingly teaches that the deflector must be placed directly in front of the vehicle; a position Uniroyal interprets as meaning the front of a car radiator.

Nevertheless, these differences are superficial compared to the similarities. The '876 patent seeks the same goal as the Constantin patent. Saunders' objective is to introduce an invention that operates differently from previous devices. He states in his patent: ". . . rather than streamlining the vehicle body, . . . to afford a smooth and uniform airflow, thus creating a difficult manufacturing problem, as well as reducing the body capacity of the vehicle, the device of the instant invention produces a relatively wide diffusion of the air impacting the forward portion of the trailer, and causes the same to readhere to the body of the truck rearwardly of the front portion thereof in a relatively smooth and even manner." P's Exh. 158, Col. 1, lines 35-44. Moreover, the '876 patent utilizes a device whose success is dependent on the principles taught in the Constantin patent and the aforementioned scientific literature: the patent discloses a flat plate that widely deflects the airflow away from a bluff body towards the face and up to the sides of the vehicle so as to reattach rearward of the front portion of the rectangular body. An explanation is provided in the specifications as to the supposed novelty of the patent: "As expected, such a deflector added to a tractor alone will increase the drag, but the drag of the combination is significantly and unexpectedly reduced." Exh. 158, Col. 2 lines 9-12. The subject matter of the

Constantin patent and the scientific literature teaches that very same principle.

The scientific literature presented by the plaintiffs discloses the concept of "favorable interference" between two bodies. Tr. 1101-2. Favorable interference is a phenomenon that occurs when a combination of two objects is placed in an airflow and the total drag of the combination is lower than the sum of the drag of the two bodies acting independently in the airflow. This same concept was referred to as sheltering in the University of Maryland report. Tr. 1102, Exh. 112, at 7-8. Shielding takes place when the drag of the combination of two bodies is lower than the drag of either body acting by itself. Shielding is also a form of favorable interference. According to Dr. Widnall, the Saunders invention utilizes the phenomenon of favorable interference. Tr. 2994.

The Eiffel publication shows the principle of drag reduction by shielding a frontal high drag body. Tr. 1103. Eiffel discloses placement of one disc or rectangular flat plate in front of another of equal diameter with the result that the drag of the combination is lower than the drag of the single plate.

Hoerner's *Fluid Dynamic Drag* contains examples of drag reduction by shielding a frontal high drag body. For example, Hoerner illustrates that drag reduction of a large body can be obtained by placing a smaller disc in front of the larger body to reduce the drag of the combination so that it is lower than if the air flow hit the larger body alone. Tr. 1103-4. Hoerner also demonstrates that a decrease in drag coefficient can be achieved by attaching a load to a parachute. His experiments reveal that the drag coefficient of the parachute by itself has a value of 1.35; when the load or disc is placed in front of it, the drag of the parachute is reduced to .93; the drag of the combination of parachute and disc is lowered from 1.35 to 1.06, or a 25% drag reduction.

The Eiffel and Hoerner experiments demonstrate that the drag of a combination is reduced by the shielding action of a forebody. Tr. 1105, P's Exh. 27. The '876 patent differs from Eiffel in that Saunders achieved his result by experiments that used a disc mounted in front of a blunt-faced cylinder. Eiffel,

on the other hand, utilized a disc in front of a disc and varied only the distance between the discs whereas Saunders varied the distance and diameter of the disc. Still, Eiffel teaches that the use of two discs in conjunction with one another can create a single recirculating eddy and result in deflecting a streamline over and away from the second disc by having the airstream impinge against the front disc. Tr. 1019-20; Exh. 113, at 55, Fig. 32. Although the shapes are different, both the Saunders device and the Eiffel teachings are sufficiently blunt-faced to allow a wide deflection of the airflow. Tr. 1027. The depictions in the Hoerner book are even more relevant in that they show the shielding of a large body by a small disc and show that the drag of a disc is very similar to the drag of cube. The Hoerner findings are thus analogous to a deflecting baffle for a bluff body, such as a tractor-trailer vehicle.

3. *Ordinary Skill in the Art*

Rudkin-Wiley asserts that one reasonably skilled in the applicable art in the 1960's would be an engineer experience in the design of tractor-trailers, but not an expert in aerodynamics. To support this view, Dr. Buckley testified that the level of ordinary skill during the 1960's was best represented by the skill of engineers who conducted the University of Maryland tests in the 1950's. Exh. 117-119. In that study, the engineers were specialists of streamlining principles. That fact is not inconsistent with Dr. Widnall's testimony. Dr. Widnall was asked at trial her opinion as to the level of skill a hypothetical person would need in order to develop a novel drag reduction device in combination with a land vehicle such as a tractor-trailer between 1962-1964. She testified that such a person would not necessarily need to have a formal education in fluid mechanics or aerodynamics, but would need familiarity with those principles. Tr. 503. The basis for Dr. Widnall's comments was her personal experience as a teacher of aerodynamics at M.I.T., and as a student at M.I.T. just prior to the filing date of Saunders' first application in 1962. Tr. 1387. Streamlining is concerned with designing contours that decrease air resistance; aerodynamic and fluid mechanic principles are concerned with the action of

fluid upon bodies. All streamlining principles necessarily employ aerodynamic or fluid mechanic principles since, in order to develop contours able to resist the flow of air, an understanding of the interaction of airflow on moving vehicles is necessary.

A knowledge of tractor-trailers seems unnecessary in light of the particular problem facing an inventor of a drag reducing device. As Dr. Widnall testified, any theory of aerodynamics eventually must be tested on the particular body for which an aerodynamic device is intended. This is so because it is impossible to predict the exact effect the actual currents will have on any one body. Tr. 556. An expertise in tractor-trailer vehicles would not then aid an inventor in applying a drag-reducing device to such a vehicle, because even an expert would be unable to predict the result an aerodynamic device would have on a tractor-trailer vehicle. Therefore, the court finds the level of ordinary skill in the art to be an engineer familiar with aerodynamic or fluid mechanic principles.[2]

4. *Secondary Considerations*

After acquiring exclusive rights to the '876 patent from Mr. Saunders in 1966, Rudkin-Wiley launched an intensive multimedia promotional campaign using advertising, publicity, personal appearances by Mr. Wiley before the trucking industry,

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2 The court in *Saunders v. Air-Flo Co.*, 646 F.2d at 1207 accepted a lower level of skill, that of an engineer with experience in truck body design, although not an expert in aerodynamics. However, the court noted that the district court had not made a finding as to the ordinary level of skill in the pertinent art and the parties had not argued the point before the Court of Appeals. The Circuit Court, therefore, did not have a developed record to support its finding. In the instant case the plaintiffs presented significant and persuasive evidence of the appropriate level of skill in the art. Because they were not parties in the *Air-Flo* case they were not estopped from presenting such evidence and this court is not precluded from making a finding different from that of the Seventh Circuit. *See In Re Teltronic Services, Inc.*, 762 F.2d 185, 190 (2d Cir. 1985) (doctrine of *res judicata* only applicable when case involves same parties or their privities). *Cf. Parklane Hosiery Co. v. Shore*, 439 U.S. 322 (1979) (abrogating mutuality requirement for application of collateral estoppel if party against whom doctrine is applied had a full and fair opportunity to litigate its claim in prior case.)

and vigorous sales efforts. No real evidence of the trucking industry's receptiveness to the air deflector manifested for seven years. And then, in 1973, demand for a gas-saving device increased to stave off the effects of the then current oil crisis. As such, there is no evidence of a long-felt need.

On the other hand, it is undeniable that Rudkin-Wiley spawned a multi-million dollar industry with the introduction of a wind-reducing device for tractor-trailer vehicles. Whether others would have produced a similar device is unknown since there was no impetus to invent a gas-saving device until the 1973 oil crisis. The court agrees with the conclusion of the Seventh Circuit in *Saunders v. Air-Flow*, 646 F.2d at 1208, that because of these circumstances, "the commercial success is less likely to raise the inference that many skilled people had addressed the problem over time without finding the solution."

Finally, Rudkin-Wiley repeatedly argued that the invention produced an unexpected result in that it went against the "common-sense idea" that placing a bluff shield on top of a tractor would increase, not decrease, drag. A "commonsense idea" does not fulfill an unexpected result standard only because it is shared by the trucking industry, as Rudkin-Wiley suggests. It is whether experts in the field think the invention to be unexpected that is significant. A review of the literature available at the time of the granting of the '876 patent demonstrates that the result was far from unexpected. In fact, the result was precisely what had been predicted by the literature.

5. *Conclusion as to "Obviousness"*

The '876 patent is a combination patent in that it combines teachings from more than one reference. A judicially created doctrine of combination patents, had, in the past, viewed these patents with skepticism. This doctrine is no longer applied. *Environmental Designs v. Union Oil*, 713 F.2d 693 (Fed. Cir. 1983). To categorize certain patents by way of rigid formulas is in contravention of the standard of section 103. *Richdel, Inc. v. Sunspool Corp.*, 714 F.2d 1573 (Fed. Cir. 1983). It is now recognized that "virtually all inventions are combinations of old elements." *Environmental Designs, supra*, at 698. Conse-

quently, a patent whose subject matter as a whole is nonobvious is still valid even when the combination of old elements in the patent do not reveal a "synergistic" result or a "new and different" function. *Sakraida v. Ag Pro, Inc.*, 425 U.S. 273 (1975). The court in *In Re Sernaker*, 702 F.2d 989, 994 (Fed. Cir. 1983) carved out a two-part inquiry that is a more effective way to review the obviousness of a combination patent because it comports with the section 103 standard. Utilizing this test, the following questions are posed: (1) whether a combination of the teachings of all or any of the references would have suggested (expressly or by implication) the possibility of achieving further improvement by combining such teachings along the line of the invention in suit; and (2) whether the claimed invention achieved more than a combination which any or all of the prior art references suggested, expressly or by reasonable implication." *Id.*

In this instance, the combination of the teachings of the prior art references would have suggested the possibility of achieving further improvement by combining such teachings along the line of the '876 patent. An engineer with aerodynamic experience, upon viewing the University of Maryland studies, would have discarded the viability of streamlining the actual body of a tractor-trailer since the studies showed that method to be costly and inefficient. The Maryland studies revealed that an add-on streamlining device, such as a fairing, designed to direct the airflow over and above the gap in a tractor-trailer vehicle would be much more effective. However, the studies also admitted that the device was impractical as long as it was attached to both the tractor and trailer sections of the vehicle since this obstructed the turning capacity of the vehicle. The Stamm patent would have revealed that add-on streamlining devices could be attached to the tractor and trailer sections in such a way as to avoid the problems associated with fairings and, at the same time, direct the airstream above and over the gap between the tractor and trailer. The employment, however, of large, cumbersome, U-shaped frames for both the trailer and tractor might well have inspired an inventor to seek a simpler way to reduce air drag.

Constantin and the aerodynamic literature would have provided the ideal alternative to reduce drag. Constantin, in its introduction, boasts its ability to reduce drag encountered by vehicles with large carrying capacities without increasing deadweight. It and the other literature disclose that a simple blunt-edged deflector placed in front of a large bluff body can reduce drag. The court finds persuasive Dr. Widnall's testimony that the Constantin patent and the "favorable interference" data, combined with the Stamm and the bug deflector patents, would have suggested to an engineer with knowledge of aerodynamic principles the design of a wind-deflecting baffle that could be easily mounted on top of a tractor cab. Together, the references would have suggested the desirability of combining Constantin's theory with Stamm's practical application suggestions. *See In Re Imperato*, 486 F.2d 585, 587 (CCPA 1973) (a combination is not obvious "unless the art also contains something to suggest the desirability of the combination.") It is not by hindsight that this conclusion is made. The fact that the Constantin patent and the Stamm patent both reveal in their Statement of the Purpose an awareness of the problems of wind resistance faced by vehicles with large carrying capacities reveals that it would have been desirable and obvious to one of ordinary skill in the art at the time to combine the patents.

Additionally, the '876 patent did not achieve more than the combination of the prior art references suggested. Rudkin-Wiley asserted at trial that its patent achieved more than the combination of prior art because it disclosed an optimum reduction formula and an air impervious feature not found in any of the references. It is true that none of the prior art references expressly suggested these features; however, there was a reasonable implication that, in designing a workable device, the exact placement of a baffle would have to be adduced.

The features of the '876 patent do not carry with them a new unexpected result. The invention's novelty for which Saunders obtained a patent was the disclosure of an "optimum drag reduction formula." The formula is not impressive in this field of technology for the height and positioning ratios are merely instrumental in carrying out the combined teachings of the prior

art. An inventor ordinarily skilled in the art would have known that any aerodynamic principle revealed on paper would also require further experimentation in order to extract the exact parameters that would make the device work. As Dr. Widnall explained, no matter what the prior art disclosed, an inventor with aerodynamic skill could have predicted what would happen to the flows of his or her aerodynamic invention with sufficient accuracy to calculate on paper the design of the device. Only by conducting idealized experiments using the disc-cylinder model or by conducting wind tunnel tests could an aerodynamicist work out the exact design of his or her invention. Tr. 556. The court thus finds that there was an inherent implication in the prior art that anyone seeking to combine its teachings would have to arrive at a modification peculiar to the particular vehicle for which the aerodynamic device was designed.

The section 103 standard prohibits the courts from relying on the manner in which the invention was made to negative an otherwise valid patent. To a degree, however, the manner in which aerodynamic inventions are arrived at is relevant. Unless patents are reserved for an inventor who emerges with a new principle or a new application of an aerodynamic principle, a patent could be issued for every formula derived in installing a device such as a baffle. As Dr. Widnall revealed, a great many changes occur whenever an aerodynamic device is applied to a three-dimensional vehicle so that a designer will always need to readjust his or her initial formulas and calculations. Tr. 553. This was borne out at trial, when it was revealed that by a slight alteration of its shape and curvature, the Rudkin-Wiley baffle responded less "optimally" to the drag reduction formula. Tr. 2369.

Given these circumstances, and the fact that the commercial success factors provided ambiguous indicia of obviousness, Uniroyal and Premix have sustained their burden of showing by clear and convincing evidence that the '876 patent would have been obvious to an engineer with experience in aerodynamics and fluid mechanics during 1962-1966. The differences between

the prior art and the claims at issue are such that the subject matter of the '876 patent *as a whole* would have been obvious.

III. *Infringement*

A. *Literal Infringement*

Infringement is a question of fact to be determined first by a comparison of the patentee's claim with the accused device. *Graver Tank & Manufacturing Co. v. Linde Air Products Co.*, 339 U.S. 605 (1950). The state of the prior art and the prosecution history of the patent application are important factors in determining the meaning of a patent claim. *Decca Limited v. United States*, 420 F.2d 1010 (Ct. Cl. 1970). Literal infringement is met when the properly construed patent claims describe the infringing product. *Atlas Powder Co. v. E.I. Du Pont De Nemours*, 750 F.2d 1569, 1579 (Fed. Cir. 1984).

A comparison of the '876 patent claims with the Uniroyal device reveals several differences. Claims one and two of the '876 patent disclose an "airflow deflecting baffle" for "diverting the air flow relatively widely" in addition to a "low pressure air eddy in said gap to reduce the frontal air pressure against the trailer."

The inventor of the Uniroyal deflector, Robert Dorsch, designed his wind-reducing device as a continuously curved shape that would direct the airflow with a minimum of separation directly to the desired parts of reattachment. Tr. 93-4, 4710-11. Unlike the '876 patent, the Dorsch device emphasizes smooth contours and attached flow. Tr. 1073-4. The Dorsch device thus operates on an aerodynamic principle more similar to a fairing than a deflecting baffle. Therefore, there is no literal infringement of the claim regarding a baffle that diverts the airflow widely. Furthermore, wind tunnel tests conducted by Dr. Widnall revealed that there is no eddy creating a low pressure area in the gap. Tr. 1085.

Claims 3 and 4 require that the baffle be mounted in "substantially air impervious relation" to the tractor cab. The Uniroyal deflector is mounted on the tractor cab with its lower edge 3 5/8 inches away from the roof. Both parties' experts, Dr. Widnall and Dr. Buckley, conducted wind tunnel tests of the

Uniroyal deflector that showed a high velocity flow of airstream entering the slot.[3] Tr. 4827-9, 1084. The experts could not agree on the meaning of "substantially air impervious" although both agreed that "air impervious" defines a solid surface that prevents air from entering a region. Tr. 1077.

To determine a meaning of a phrase in a claim, reference must be made to the specifications. *Application of Mattison*, 509 F.2d 563, 565 (CCPA 1975). There are four relevant references pertaining to the "substantially air impervious" phrase in the specifications. The first reference describes the presence of an air eddy behind a deflector in Fig. 2. The specification states:

> "air flow follows course of . . . being deflected upwardly to a distance above the sharp corner at the top of the trailer and then reattaching itself smoothly to the top surface at a position beyond the abrupt juncture. This smooth air flow creates a reduction in pressure in the space between the rear of the tractor and the front of the trailer, and *such air as flows into the area circulates*, as indicated diagramatically in Fig. 2, *in reduced pressure eddies*. Exh. 158, Col. 3, lines 56-63 (emphasis added).

In Figure 10, two circulating eddies rotating in opposite directions are depicted behind the baffle between the tractor-trailer gap. Numbered 56, these eddies are described as being referred to earlier in connection with Figure 2. Exh. 158, Col. 5, lines 9-12.

A third reference is an illustration resembling the Stamm patent, Fig. 12, which reveals a shield positioned on the forward

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3 A video recording of Dr. Widnall's results played at trial revealed that the flow was so strong through the slot that it created an eddy which rotated counter to the direction of flow that moved off the trailing edge of the deflector. Tr. 1065-6, Exh. 301. There was no such eddy pattern when the slot was closed. Tr. 1068, 1088. Rudkin-Wiley erroneously concluded that there was "no significant measurable amount of flow passing through the slot" of Uniroyal's device, *see* Defendant's Reply Brief at 26, since Dr. Buckley's experiments showed that the deflector had greater drag when the slot was open. Exh. A1, p. 8, Tr. 5086-89. The actual effects on drag reduction are not at issue here; only whether the slot is in substantially air impervious relation to the tractor cab.

edge of the tractor "to deflect the main stream of air upwardly . . . and over the roof of the trailer while *turning back a portion thereof to form an eddy or bubble 64* which serves further to deflect air from the front of the trailer 61, reducing the drag of the combination." Exh. 158, Col. 5, lines 50-55. (emphasis added). The eddy is situated above the tractor cab, and not the tractor-trailer gap. Figure 12 also reveals a lip mounted at the rear of the cab intended to "assist in retaining the eddy 6 and in preventing *further interchange between the outside air and the air in the gap* between the rear of the tractor and the trailer." *Id.*, at 55-59. (emphasis added).

Finally, Fig. 15 reveals a rotating eddy also behind a forwardly mounted shield with a lip mounted in the rear. The specification explains:

> Here, the air flow 75 is similar to that shown at 63 in Fig. 12 and an eddy 76 is provided . . . . However, in this modification the shield is provided with a slot 78, which allows a second current of air to flow along the roof and over the lip 77, which further stabilizes the bubble 76 and *precludes the entrance of air into the gap between the tractor and trailer.* Exh. 158, Col. 5, lines 63-70. (emphasis added.)

A reading of the specifications indicates a presumption by the author that a slot which allows air to flow vigorously under the shield will not satisfy a "substantially air impervious" condition. The only intentional unimpervious slot is represented in Figures 12 and 15, and in those configurations the slot is accompanied by a lip in order to "preclude the entrance of air into the gap."

Overall, the third and fourth claims of the '876 patent indicate that there should be no actual opening between the edge of the baffle and the cab roof, but that to the extent that there will be an inevitable escape of the airflow in the tractor-trailer gap, a reduced pressure eddy will circulate in the gap.

Therefore, the Uniroyal/Premix deflector does not infringe the literal claims of 3 and 4 of the '876 patent.[4]

B. *Application of the Doctrine of Equivalents*

An inquiry into infringement does not terminate with a finding that all of the literal elements of a patent are not present in

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4 This conclusion accords with the patent file history. After his continuation-in-part patent application was rejected on October 28, 1962, Saunders filed an amendment on March 1, 1965, which included the following claim:

> 18. In combination, a tractor-trailer vehicle provided with a space between the tractor cab and the trailer, the roof of said tractor cab being disposed in a horizontal plane below the roof of said trailer, and a deflecting shield disposed near the rear portion of said cab roof comprising a substantially imperforate substantially vertical baffle having its lower edge secured to said cab and projecting upwardly above the top of the roof and extending transversely across said cab roof a substantial distance so that an air stream passing toward said trailer impinges thereon and passes around the perimeter of the surface of said baffle and by-passes said space to reduce drag against the front end of said trailer. (Exh. 162, p. 32).

The proposed claim was rejected by the patent office on March 16, 1965, because, although the lower edge was "secured to the cab," the limitation did not adequately distinguish the Stamm reference. Exh. 162, p. 44-45.

Saunders cancelled claim 18 and inserted claims 22 and 23 which ultimately issued as claims 3 and 4 of the '876 patent. The pertinent portion of claim 22 reads:

> In combination with a tractor-trailer vehicle having a gap between the tractor and the trailer, said tractor having a cab with the roof thereof of less height than said trailer, a substantially solid upstanding airflow deflecting baffle mounted to extend above the cab roof and having its lower edge in substantially air impervious relation therewith, for diverting the substantially entire air flow relatively widely in a manner to avoid entry of the airstream into the gap . . . (Exh. 162, p. 47).

Saunders urged the patent office to patent claim 22 based on the following argument:

> However, in this claim, the baffle is defined as substantially solid, or air impervious, and as having its lower edge in air impervious relation with the roof of the tractor cab. This clearly distinguishes over the Stamm reference wherein the baffle is spaced from the roof of the cab, . . . (Emphasis added) (Exh. 162, p. 48).

the accused product. If it did, an inventor could copy the essence of a patent and escape liability by disguising or altering the patent in meaningless ways. Such a loophole would defeat the purposes of protecting an invention—it would deprive the original inventor of the fruits of his labor and promote concealment of technology beneficial to society. *Graver Tank*, *supra*, at 607.

The doctrine of equivalents was established to prevent patent fraud. *Id.*, at 608. Under the doctrine of equivalents, a product will be deemed to have infringed a patent "if it performs substantially the same function in substantially the same way to obtain the same result." *Id.*

The Uniroyal deflector has the same result as the '876 patent: it reduces frontal drag resistance encountered by tractor-trailer vehicles to decrease fuel consumption. The product also appears to function in a similar way as the '876 patent in that it diverts the airflow away from the tractor-trailer gap by use of a substantially vertical surface mounted on top of a tractor cab. The main source of contention between the parties is whether the Uniroyal deflector performs in substantially the same manner as the '876 patent. In other words, do the two devices employ the same aerodynamic principles in the same fashion?

The Saunders device was denied a patent twice before one was issued in 1966. Each time, the patent office rejected the patent application as being obvious in light of several patents, including the Stamm patent. In his Statement of Purpose in the '876 patent, Saunders expressly disassociates his device from conventional streamlining techniques: "Still another object of the invention is the provision of a device which will operate in a manner different from that of previous devices which contemplate similar results." Exh. 158, Col. 1, lines 32-35. The previous devices listed include a streamlined body, streamlined vanes and fairings. These techniques were said to all differ from the '876 patent in that the claimed invention "employed a deflecting device mounted on the tractor which deflects the onrushing air in such a manner as to occasion a very large separation of air flow." Exh. 158, Col. 1, lines 70-73.

The Uniroyal deflector operates on different aerodynamic principles from the '876 patent. Its inventor, Robert Dorsch, was commissioned to design a drag reducing device for Uniroyal in 1974. He obtained a Rudkin-Wiley deflector as a model to study and concluded that the device was a flat plate, high drag device designed to deflect air almost perpendicular to the cab's centerline and around the face of the trailer. Tr. 90, 134, 4364. Dorsch believed his assignment was to design a new device that would be more effective, practical and aesthetically pleasing. Tr. 90. Dorsch investigated streamlining concepts and decided to develop a streamlined, low drag device by which airflow could be controlled and directed to the desired point of attachment. Tr. 91, 4364. The result was a deflector shaped somewhat like a hemispheric shell with a smooth, curved forebody. Much like a fairing, the deflector was designed to allow the flow to leave the trailing edge of the device smoothly and without abrupt change of direction so as to flow onto the leading edge of the tractor.[5] Tr. 1033, 1047-8, 4705, 4712-16, 4737-8.

Moreover, the device differed from the '876 patent in that it was designed to be an adjustable deflector. The deflector is permanently mounted on the rear of the cab and can be made compatible with trailers of different sizes by altering the slope of the deflector through certain preestablished pin settings. In this way, the deflector is a "one-size-fits-all" device. This differs from the '876 patent, which requires the distance and height of

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5 Defendant argues that the Uniroyal deflector is a high drag device. Defendant's Reply Brief, at 22. It bases this conclusion on experiments conducted which compared the Uniroyal deflector with the Rudkin-Wiley device and which found the Uniroyal device to have a greater drag. There are indications that the Rudkin-Wiley deflector has undergone many significant changes in its shapes, so as to diminish the significance of these findings. Tr. 2046-48, 2302-11, 4751-65. Furthermore, the court is instructed to compare the accused product in an infringement action only with the actual patent—not with the commercially reproduced version of the patent. *Amstar Corporation v. Envirotech Corporation*, 730 F.2d 1476, 1481-82 (Fed. Cir.), *cert. den.* 105 S. Ct. 306 (1984). Although the commercially available incarnation of the '876 patent may be a low drag device, the '876 patent itself describes a device that is a high-drag body which causes a wide deflection of the onrushing airflow. Exh. 158, Col. 1, lines 66-72; Col. 2, lines 1-16.

its baffle to be customized according to the dimensions of a tractor-trailer vehicle.

It is thus found that the Uniroyal deflector differs in two substantial ways from the '876 patent. Its design is based on substantially different principles than the '876 patent and these principles were well-disclosed in the prior art. Not only does the Uniroyal deflector modify the teachings of the '876 patent by disclosing a fairing type device, instead of a baffle, to reduce drag for a tractor-trailer vehicle; the Uniroyal deflector also offers a new and major improvement over the '876 patent with its adjustability feature.

These two distinctions in the way the Uniroyal deflector operates also serve to make the .7 equation of the '876 patent inapplicable. Saunders derived the height and distance equation by conducting idealized experiments using a disc in front of a cylinder. These experiments are very similar aerodynamically to tractor-trailer baffles, since, according to Hoerner, *see* supra, there is little variance in drag between a disc and a cube. Yet, because there is a wide variance between a low drag and a high drag shape, the .7 optimum drag reduction formula is inapplicable to a low drag hemispherical fairing-type deflector. Tr. 1029. This fact is illustrated by the height requirements of the '876 patent. Staging the height of the baffle .7 the difference in height between the tractor and trailer will allow a baffle to deflect widely the airflow over itself and the second shape due to the impact of the airflow hitting against its flat edges. This same height may not be sufficient to direct the airflow over a fairing-type deflector and over the trailer behind it. Because a streamlined shaped deflector does not widely disperse the air, the airflow may well come off the smooth shape and, because of the shortness or slope of the deflector, hit the trailer face in a positive drag. Tr. 1033.

Nevertheless, Rudkin-Wiley maintains that the parameters of the Uniroyal device have, on the average, infringed the height and distance parameters of all four claims of the '876 patent. According to claims 1-4, the wind deflector must be placed a certain distance from the front of the trailer according to the width of the trailer. Additionally, the baffle's height is deter-

mined by the difference in height between the tractor cab roof and the trailer roof. The Uniroyal device is an adjustable deflector having release angles that alter the slope of the deflector according to the height differential and the gap distance of the tractor and trailer. The mounting instructions advise mounting the deflector at the rear of the tractor cab and finding the correct slope for the deflector according to the variables above.

Even if the installation of Uniroyal's device results in literally duplicating the distance and height requirements of the '876 patent, there is no infringement because Uniroyal does not rely on those specific parameters to mount its deflector. The height of the deflector is always the same; the distance of the deflector from the trailer is a variable dependent upon the gap between the tractor and trailer. The width of the trailer is never a factor. Instead, the Uniroyal deflector relies on its slope for optimum results; a slope determined by the relationship between the height differential and gap distance of the tractor-trailer vehicle.[6] The Uniroyal deflector, therefore, does not infringe upon the dimensional or positioning claims in the '876 patent.

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6 The manner in which Rudkin-Wiley claims infringement of its optimum drag reduction formula deserves mention. Claims one and two set the height of the '876 baffle at "substantially" 0.7 of the difference in height between the top of the cab and the top of the trailer. The baffle is to be positioned a distance from the front of the trailer equalling "approximately" 0.7 the half width of the trailer. Claim three expands upon the ratio by claiming a baffle between 0.5 and 0.9 of the height difference and a position between 0.3 and 2.0 of the trailer half-width from the front of the trailer.

The Uniroyal deflector is a standard height and Uniroyal advises its customers to mount the deflector at the rear of the cab. The slope of the deflector is adjustable, varying with the height of the trailer and the distance between the trailer and the cab. The optimal slope is a function of the ratio between the height differential and the gap distance. Tr. 1056-1058. Therefore, rather than varying two parameters according to a constant determined ratio, as in the '876 patent, the Uniroyal device varies one parameter according to a variable ratio.

Rudkin-Wiley argues that the effect of the Uniroyal size and placement is to fall within the parameters set forth in its claims. It arrives at its conclusion by noting that trailers have a standard width of 96 inches, giving a half width

C. *Infringement Conclusion*

Because the Uniroyal device achieves its drag reducing effect using aerodynamic principles different from those described in the '876 patent, and the Uniroyal device does not literally infringe on the '876 claims, the Uniroyal device would not infringe upon the '876 patent even if that patent were valid.

IV. *Unfair Competition Claim*

Rudkin-Wiley has also raised an unfair competition claim under section 43(a) of the Lanham Act, 15 U.S.C. § 1125(a). Rudkin-Wiley objected to the overall aggressive marketing tactics carried out by the plaintiffs beginning in 1975 to edge in on what at the time was a wholly-owned market share of Rudkin-Wiley. This fact, by itself, is not of significance because commercial competitors are allowed to pursue aggressive marketing campaigns as long as they do not seek to acquire a market share by using a false description or representation concerning goods in interstate commerce.

Rudkin-Wiley challenges the legality of two assertions made by Uniroyal in its advertisements. Uniroyal boasted the following in a full-page advertisement in the New York Times: "Dis-

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of 48 inches, and will usually be located between 24 and 60 inches from the back of the cab. Applying its fixed ratios to these distances gives height and location parameters which include the usual placement and height of a Uniroyal deflector.

This argument ignores the different principles used by the Uniroyal device and the '876 patent. The Uniroyal device is designed to guide the airflow in a precise manner to insure its reattachment at an optimum location on the top of the trailer. The '876 baffle is designed to widely disperse the airflow, permitting its reattachment to the trailer at some point behind the trailer's front. These two approaches require different considerations in placement of the deflectors. The fact that optimal placement of the '876 baffle may coincide in some instances with optimal placement of the Uniroyal device does not demonstrate that the Uniroyal device infringes upon the '876 formulae. The '876 claims cannot be viewed as claiming specific locations for an air deflector, but rather as formulae for determining optimal height and location of the deflector. In other words, placement and slope of the Uniroyal device is not based upon the formulae claimed by the '876 patent, but on a completely different formula that, under some circumstances, gives a similar result.

covered by Uniroyal: A simple piece of plastic that could save long haul truckers 10-to-15% on fuel." Exh. A21. Further on in the ad, it is declared that the product "foils air resistance in ways invented by Uniroyal mathematicians and missile scientists." Although somewhat misleading, there is nothing erroneous about these depictions. For in truth, Uniroyal invented a product that foils air resistance and saves fuel for truckers, and it is a product that foils air resistance in ways invented by the missile scientists of the Poseidon missile program.

Furthermore, Uniroyal had a good faith basis upon which to believe that Rudkin-Wiley could only achieve 5% fuel savings with its device while Uniroyal could achieve more. In four tests conducted by the Bendix Corporation, Uniroyal achieved a fuel savings of over 40% while Rudkin-Wiley achieved only around 5% fuel savings. Although the other two tests revealed no fuel savings by either party's device, there was evidence that Uniroyal's deflector could achieve a higher fuel savings than Rudkin-Wiley's. *See* Exh. 115.

Although Uniroyal's claims that it "invented" the manner that fuel reduction is achieved may be somewhat misleading, these claims do not amount to Lanham Act violations. Section 43(a) not only bars blatant falsehoods; it also embraces representations which are "so significantly misleading that the reasonably intelligent consumer would be deceived about the product's inherent qualities or characteristics. . . ." *Vidal Sassoon, Inc. v. Bristol-Myers Co.*, 661 F.2d 272, 278 (2d Cir. 1981). Rudkin-Wiley has made no showing that a misleading statement regarding who "invented" the governing principles would have an effect upon an intelligent consumer's perception of the product's inherent qualities. *See American Home Products Corp. v. Johnson & Johnson*, 577 F.2d 160, 165-66 (advertisement should be tested by public reaction). Furthermore, there does not appear to be any basis for the court to assume that a misrepresentation regarding the invention of a principle would have an effect on a consumer's perception of a product's benefits. Rudkin-Wiley has therefore failed to carry its burden of showing a Lanham Act violation for misrepresentations in advertising.

Rudkin-Wiley's copying claim is also without merit. Its evidence revolves around the fact that Dorsch obtained Rudkin-Wiley's commercially produced version of the '876 patent and studied it before designing the device for Uniroyal. Dorsch convincingly testified that the Rudkin-Wiley deflector was used as a starting point in designing what ultimately became a unique and aerodynamically different wind deflector. The remaining objections to plaintiffs' conduct—that they vowed to win market share from Rudkin-Wiley, and they closely studied and emulated Rudkin-Wiley marketing tactics—serve only to reveal an aggressive marketing strategy staged within the bounds of the law.

Rudkin-Wiley has also argued that Uniroyal and Premix have failed to exercise diligence in preventing infringement of the '876 patent. In light of the above discussion regarding the validity of the '876 patent and the lack of infringement in any event, the court concludes that Rudkin-Wiley has failed to demonstrate lack of diligence by Uniroyal and Premix.

V. *Conclusion*

Judgment shall enter in favor of Uniroyal and Premix and the '876 patent is hereby declared invalid.

SO ORDERED.

/s/ ELLEN B. BURNS
ELLEN BREE BURNS
United States District Judge

Dated at New Haven, Connecticut, this 31st day of March, 1986.

Federal Circuit Order Denying Rehearing

Note: This Order has not been prepared for publication in a printed volume because it does not add significantly to the body of law and is not of widespread legal interest. It is a public record. It is not citable as precedent.

UNITED STATES COURT OF APPEALS
FOR THE FEDERAL CIRCUIT

86-1300

Filed March 31, 1980

UNIROYAL, INC.,

Plaintiff-Appellee,

v.

RUDKIN-WILEY CORPORATION,

Defendant-Appellant.

PREMIX, INC.,

Plaintiff-Appellee,

v.

RUDKIN-WILEY CORPORATION,

Defendant-Appellant.

Before:

DAVIS, NEWMAN, and ARCHER,

Circuit Judges.

ORDER

A petition for rehearing having been filed in this case,

UPON CONSIDERATION THEREOF, it is

ORDERED that the petition for rehearing be, and the same hereby is, denied.

The suggestion for rehearing in banc is under consideration.

FOR THE COURT:

FRANCIS X. GINDHART

Francis X. Gindhart, Clerk

3/31/88

Date

cc: Mr. Francis T. Carr
Mr. Donald L. Otto
Mr. Thomas A. Beck

Federal Circuit Order Denying Rehearing In Banc

Note: This Order has not been prepared for publication in a printed volume because it does not add significantly to the body of law and is not of widespread legal interest. It is a public record. It is not citable as precedent.

UNITED STATES COURT OF APPEALS
FOR THE FEDERAL CIRCUIT

86-1300

Filed May 10, 1988

UNIROYAL, INC.,

Plaintiff-Appellee,

v.

RUDKIN-WILEY CORPORATION,

Defendant-Appellant.

PREMIX, INC.,

Plaintiff-Appellee,

v.

RUDKIN-WILEY CORPORATION,

Defendant-Appellant.

ORDER

A suggestion for rehearing in banc having been filed in this case,

UPON CONSIDERATION THEREOF, it is

ORDERED that the suggestion for rehearing in banc is declined.

FOR THE COURT:

FRANCIS X. GINDHART
Francis X. Gindhart, Clerk

5/10/88
Date

cc: Mr. Francis T. Carr
Mr. Donald L. Otto
Mr. Thomas A. Beck

Trial Evidence

DAVID STREED (Direct):

BY MS. NEIMAN:

* * *

Q What action, if any, did Uniroyal take with respect to its air deflector after receiving the letter?

* * *

Q I am asking for your personal knowledge of any action that Uniroyal took after receiving that letter.

A The action that we took was to release and proceed on plans to produce prototype or low-production model of the air deflector and then to continue our plans on a full-scale production of the unit.

Q To your understanding, did Uniroyal rely on the opinion letter, Plaintiff's Exhibit 130?

* * *

A Yes.

Q In what way did they rely upon the letter?

A This was the release for our further actions. Everything had been held in abeyance until this letter came through.

Q Were any sales of the Uniroyal air deflector made prior to receipt of this letter?

A No.

MS. NEIMAN: I will offer Plaintiff's Exhibit 130 in evidence. **[Tr. 33]**

MR. FIER: Your Honor, we have no objection if it is for the limited purpose of showing that a document identified as Exhibit 130 was generated on or about the date of October 31, 1974. It is obviously hearsay and we object to it from that standpoint alone. **[Tr. 34]**

* * *

THE COURT: I think for the purpose for which the plaintiff seeks to offer the letter, sir, that is, to explain the state of mind of the plaintiffs after receipt of it, that it is appropriate to be marked as a full exhibit. Certainly, not

to determine the ultimate issue, which I gather is reflected in the letter.

MR. FIER: And not for the truth of any statements contained in the letter.

THE COURT: That's correct. Just to show it is received by the plaintiffs and they took certain action along those lines.

MR. FIER: No objection.

(Plaintiff's Exhibit 130 received in evidence.) **[Tr. 36]**

ROBERT DORSCH (Cross):

MR. BRENEISEN: I would ask if the witness could be handed Defendant's Exhibit DC.

Q As I understand your earlier testimony, Mr. Dorsch, these were your calculations which you made on what you call the first production model; is that correct?

A Yes.

Q And that was in November 1974?

A Yes. **[Tr. 175]**

SHEILA WIDNALL (Direct):

BY MR. BECK:

Q Dr. Widnall, I would like to ask you whether you agree or whether you disagree with the following statements which were made by Rudkin-Wiley to the 7th Circuit Court of Appeals in the appeal of the decision rendered in the Northern District of Indiana, South Bend.

The first statement:

> The use of a large baffle type deflector positioned on the roof was the direct opposite approach to that of streamlining and to Saunders' earlier **[Tr. 1096]** approaches which were designed to maintain a constant attachment of the air stream to the body of the vehicle. The baffle-type deflector caused the opposite effect, a detachment and separation of the air flow from the body of the vehicle.

A I agree with most of the statement. The phrase that I don't have any personal knowledge of is the phrase that talks about Saunders' earlier attempts, because I really have no way of knowing what those are.

I have seen some pages from his notebook that indicate turning vane-like devices, but I certainly don't have a complete record of the various concepts that he looked at. **[Tr. 1097]**

* * *

Q The second point, Dr. Widnall, states—and I quote:

> "There are three different relevant aerodynamic devices known, one of which is the Saunders baffle and the remaining two a conduit and a fairing, which are streamlining devices."

A Yes, I would agree with that statement.

Q This pertains, of course, to drag reduction?

A To drag reduction.

And the conduit is the device referred to in Stamm. Is that the sense of the word "conduit"?

Q The next point:

> "A baffle is something which obstructs flow rather than conducts flow."

A Yes.

Q Do you agree with that? **[Tr. 1098]**

A Yes, I agree with that.

Q The next point:

> The Saunders baffle is readily distinguishable from streamlining devices, both in their structure and manner of operation.

A Yes, I agree with that.

Q The next point:

> "A fairing performs its function of drag resistance in a manner diametrically opposite to that of a baffle-type deflector."

A You said "drag resistance." Did you mean drag resistance or drag reduction?

Q All I can do is quote to you what—if it's unclear as to what's meant—

A If you would substitute the word "reduction" for "resistance"—read that phrase again.

Q "A fairing performs its function of drag"—I have "resistance"; it may be that I am wrong—

> "in a manner diametrically opposite to that of a baffle-type deflector."

A If the word "resistance" is replaced by "reduction," I would agree with that. The word "resistance" doesn't make much sense.

Q "A streamlining device operates by avoiding air **[Tr. 1099]** separation, whereas a baffle operates by creating air separation."

A Yes, I agree with that.

Q "The streamlining device of Stamm would have to be rotated 90 degrees into a vertical upright position on the truck roof in order to convert the Stamm streamlining device into a Saunders baffle."

Before you answer that, let me put the Stamm diagrams on the easel.

A If I for the moment take the Stamm device to be the device with the geometry sketched in in figure 2, then I think it wouldn't have to be rotated quite 90 degrees to become a baffle. Perhaps 60 degrees would be sufficient.

If it rotated a full 90 degrees, the forward curve would be pointing forward, so, since that would be over-rotating it, one would certainly not need to rotate it past the point where that upward curve surface was itself vertical.

> MR. BECK: May I state for the record that the quotations that I have made have come from pages 11, 15 and 16, 27, 34 and 35. **[Tr. 1100]**

* * *

Q Dr. Widnall, let me refer you to figure 2 of the Constantin drawing there. What is element B in the drawing of figure 2?

A I would refer to it as a shallow cone.

Q Is that designed to, in your opinion, produce the same effect as element B in figure 1?

A Yes. Constantin discusses that issue in his patent, and he says that, if one wishes, one may replace this shield, which is the element B in figure 1, with a cone. Then he specifically adds that one may do this as long as the lateral deflecting capability is not thereby reduced, **[Tr. 1156]** which means to me that, if one is to replace the disc with a cone, the cone must be chosen in such a way as to produce the same sort of wide deflection that would be produced by the flat disc. **[Tr. 1157]**

* * *

SHEILA WIDNALL (Cross):

BY MR. BRENEISEN:

* * *

Q Can you tell me what your understanding of the structure of figure 5 is in Constantin?

A Well, let me say at the outset I can't tell from looking at figure 5 whether one is dealing with a set of conical structures or a set of, you know, two-dimensional or, you know, plate-like structures, because we see only the side view. I don't know if that's important.

Q The translation, which is Plaintiffs' Exhibit 51, says figure 5 illustrates on a smaller scale a vehicle front part equipped with a shield formed out of parallel sheets.

A Right. Okay. So it is a set of sheets which I guess, in the view shown here, would extend out of the paper for some distance. Okay. It is a set of sheets, multiple sheets, that he has suggested as yet another way to prevent the air from flowing onto the face of the vehicle.

Q Would these be what sometimes is referred to as conduits?

A I would use the term "turning vane."

Q You draw the distinction between a turning vane and a conduit? **[Tr. 1197]**

A I am not sure I know what the specific definition of a conduit is and how it might differ from a turning vane.

Q You are familiar with the Stamm patent?

A Yes.

Q I believe he refers to the device he places on a tractor as a conduit. Does that help you?

A Well, not to define the term in any precision, just that he refers to a space between two turning vanes as a conduit.

Q In that context, is the figure 5 of Constantin a conduit of the type used in Stamm?

A Yes, in the sense that Stamm perhaps uses that term, "conduit." It differs in the sense that it has more vanes.

Q Constantin has more vanes than Stamm?

A Constantin has more vanes than Stamm.

Q Stamm only has one vane?

A I think that's right—

Q A conduit?

A Yes.

Q I believe you indicated that figure 1 of Constantin was, in your opinion, not streamlining?

A Figure 1 is not streamlining, that's right.

Q How about figure 5? **[Tr. 1198]**

A Yes, I would say figure 5 is streamlining.

Q How about figure 6, which also has the vanes in front of it?

A Let's see. Figure 6, as I see from the text on page 5, is evidently like figure 5, except that the sheets are conical instead of parallel.

Q He is treating all four sides of the body in figure 6?

A It's each of those shapes that we see the cross-section of in figure 6 is like a surface of a conical section, so that figure 6—the aerodynamics of figure 6 would be very similar to the aerodynamics of figure 5, and that would be streamlined.

Q Would that be in your category of streamlining?

A Category of streamlining.

Q How about figure 2?

A Figure 2 I would put in the category of non-streamlined, and the reason for that is that he warns in the text to his patent that one might—would be able to use a cone in place of a disc as long as the lateral deflection—I suppose I could—the lateral deflection capability is not reduced thereby.

What I interpret that statement to mean is that **[Tr. 1199]** you can use a cone as long as you achieve wide deflection. It's a

wide deflection would put it out of the category of a streamlining body, since a body that widely deflected would still have a relatively high drag coefficient. **[Tr. 1200]**

* * *

Q Using the figure which I will hand you as another copy of Stamm, this one being Plaintiffs' Exhibit 343-A, is the flow line passing through that conduit indicated?

A Yes, it is indicated.

Q Could you indicate what that flow line is, in red?

A I have a red pencil. You wanted me to trace the whole thing?

Q Yes, as he represents it.

A It doesn't show it going through here, but then he continues it on the other side, and I assume that means that goes through.

Q I see you have marked that on Stamm's figure 2?

A Yes.

Q Is there any reason you selected figure 2?

A Well, figure 2 is sort of a cross-section of it. It perhaps shows the relationship between the device and the air flow.

Q Does figure 1 show the relationship, too?

A Yes, it does, in a little more complicated way. **[Tr. 1215]**

Q Could you show it on figure 1, also?

A (Marks document)

Q I believe what you have just shown is the flow passing through the conduit and going up the face of the trailer, as shown on the figure 1?

A Well, I didn't actually show it in the conduit. I couldn't find any line that was marked 50, but I showed it coming out of the device and going up the front face and coming out of the vane on top.

Q It passes through the conduit over the cab?

A Evidently. I think figure 2 shows it passing through the conduit, and figure 1—perhaps this is not as clear on that, but, if it's the same figure, then it does pass through.

Q Going up the face of the trailer?

A I wouldn't say the face of the trailer. It shows it going up in back of the cab, up to the front edge of the trailer.

Q I had placed here a model which we have made, which I believe is representative of what is figure 1 in Stamm, and the yellow device on the tractor roof would be that forward conduit and the rear device on the trailer face would be the conduit 40, which he has on his trailer. I believe you have indicated that Stam [sic] is a streamlining device? **[Tr. 1216]**

A Yes.

Q Do you believe that device will work, as he describes it?

A Well, I would have to distinguish between the picture shown in the figure and what Stamm is necessary to do in order to reduce the drag of a tractor-trailer combination. I think both things are in the teaching of the patent.

Q You had made a mention of the figure. What are you referring to?

A When I refer to the figure, I am talking about, instead of interpreting the figure as a principle or a concept, if one is to interpret it as an engineering drawing of something that you just hand to a machinist and he makes it—is that—

Q I am not certain what you were referring to with respect to the drawing.

A Okay, maybe you better ask me the question again.

Q I think my initial question was whether or not you believe that the Stamm device would work.

A If I take the device that is shown in Stamm—

Q Shown in Stamm where?

A I like figure 2.

Q What don't you like about figure 1? **[Tr. 1217]**

A It's not that I don't like figure 1. I think that figure 2 to an aerodynamicist—it shows the principle that Stamm is trying to get across. It shows how the device must function in order to successfully work as a drag-reducing device. That's why I like figure 2.

If you take figure 2 and you say figure 2—we are going to interpret figure 2 as a mechanical drawing to some scale—

Q Why is it to some scale?

A Because it's not as big as a truck.

Q Is the scale in figure 2 different than the scale in figure 1, as far as you perceive it?

A I can't tell that. Figure 2, yes; figure 2 does look like it has—let me define scale, first of all.

When I say "scale," I mean that the figure—figure 1 is smaller than an actual truck. That's what I mean by "scale."

Q If it will help, you can also refer to the model.

A That's a scale model of a truck. That's even a bigger scale.

When I use the word "scale," I am talking about the fact that the drawing in figure 2 is not as large as a device would have to be constructed if it were actually to fit on top of the cab of the tractor. **[Tr. 1218]**

Q That's true with all the drawings we have been dealing with.

A Fine. So, when I refer to it as a scale drawing, I am saying that it is not the same size. There is a more precise meaning to the word "scale." If I say that figure 2 is a scale drawing, one interpretation of that is a figure 2 is a scale drawing in the same sense that every dimension shown in figure 2—

Q Are there any dimensions shown in figure 2?

A I mean the dimensions that a mechanical engineer or draftsman would pick over with a pair of rulers or dividers.

Q You're saying if it was drawn accurately to scale?

A That's what I am saying. I am saying—if I interpret Stamm, figure 2, as a scale model of a device, and I give figure 2 to a machinist and I say "Make me the device exactly to the ratios that are shown in Stamm," and then if I put that up on the top of a tractor-trailer—what was the question?

Q Will it work?

A I thought that was the question, but I want to make absolutely sure.

I don't believe that the device shown will **[Tr. 1219]** produce a sufficient deflection of the flow to accomplish the turning that is indicated in the diagram with the line 50.

Q So the answer would be no?

A Not as figure 2 interpreted as a scale drawing.

On the other hand, if I interpret figure 2 as an aerodynamic concept that Stamm is telling us to in the concept of what he is trying to do to lead the streamline up until it reattaches to the top of the trailer, as is shown, then I do believe that it would

achieve that drag reduction, but the device would not look identical to the device sketched here.

Q You would have to change what is shown in figure 2?

A You would have to change the details of the ratios as shown.

Q If we take figure 1 as being to scale, let me ask you with respect to that figure, do you believe that device will work to reduce drag?

A If you build the model exactly to the scale in every detail that is shown on this device—well, I believe—I do believe it will reduce drag. I don't believe it will be an optimum device.

I guess I interpreted your previous question as **[Tr. 1220]** being whether or not the device would lead the streamline to the top of the trailer. I don't think it will lead the streamline to the top of the trailer. It likely will, however, reduce drag. **[Tr. 1221]**

* * *

NATHANIEL WILEY, JR. (Direct):

BY MR. BRENEISEN:

* * *

Q Did you come up with a design at that point in time?

A Yes. We did not want to spend money for tooling and I designed a deflector based on the tenets of this patent that was made out of aluminum. It was an aluminum sheet that was coped to profile and bent to contour. **[Tr. 1505-6]**

* * *

Q As far as the fabrication and the positioning of the deflector, Mr. Wiley, based on your discussions with Mr. Saunders, what did you proceed with doing?

A Well, we made the deflector so that it was seven-tenths the differential height of the tractor-trailer and followed the instructions and claims in the patent.

Basically, we looked at the pictures. We had discussions in general and then I went ahead and designed it. **[Tr. 1509]**

* * *

Q Can you tell us what kind of a fuel savings you advise your customers as what can be attained by a Rudkin-Wiley deflector?

A Yes. We generally tell them four to six percent and it will vary on the exact configurations of the tractor and trailer. **[Tr. 1576]**

* * *

Q As the president of Rudkin-Wiley, are you familiar with Rudkin-Wiley's competitors in the air deflector business, Mr. Wiley?

A Yes, I am.

Q Prior to Uniroyal's entry into the market, could you indicate the competitors of Rudkin-Wiley in the deflector **[Tr. 1822]** market?

A We had Airflow and Camper Flow. That's the only two I recall.

* * *

Q Who would you consider to be Rudkin-Wiley's largest sized competitor?

A Uniroyal, Royal-Air.

Q Would you indicate who you would believe to be Rudkin-Wiley's next largest sized competitor?

A I think it might be a toss-up between B&B, and General Motors. **[Tr. 1823]**

* * *

Q As to General Motors, I believe you called that the drag foiler. Does General Motors sell the drag foiler to the general tractor, the general user?

A The drag foiler is made and sold only for GMC trucks.

Q So they only have applicability to General Motors trucks?

A They only fit GMC trucks.

* * *

Q Has the drag foiler—When did the drag foiler first appear on the market to the best of your recollection?

A I would say 1975, '76. **[Tr. 1824]**

* * *

NATHANIEL WILEY, JR. (Cross):

BY MR. MURPHY:

* * *

Q Now, Mr. Wiley, referring to the document which I showed you, which is Defendant's Exhibit H, sir, that, I think you said, was an ad of Rudkin-Wiley that appeared at or about November of 1975?

A I would say so, yes.

Q That ad describes various competitive devices that were on the market as of approximately November of 1975?

A I would say yes.

Q In fact, that's the reason that you referred to these devices in your ad; was it not, because they were competitive devices?

A They were at least—at least one of those—well, in both straight truck and tractor-trailer truck; at least one of those, I believe, is strictly for a straight truck.

Q Which one is that, sir?

A Aero Boost. And at that time Air Vane was a straight truck device.

Q Did Air Vane at a subsequent time braoden [sic] its line of products to include a device suitable for use on a tractor-trailer combination?

A Yes.

Q The others listed in Defendant's Exhibit H were all various forms of drag reduction devices for use in tractor-trailers; is that correct? **[Tr. 2423]**

A Yes.

Q One of them, sir, is described as nose cone. Is that a form of nose fairing such as you have described?

A Yes.

Q There is also referred to a device known as Airflow. What type of device was that, sir?

A That was a roof-mounted deflector.

Q There is a reference to a GMC drag foiler, which I think you made reference to on your direct examination. What type of device was that?

A That's a deflector.

Q There is also a device known as Wind Gem. What type of device was that, sir?

A That is a deflector. **[Tr. 2424]**

* * *

SHEILA WIDNALL (Direct):

BY MR. MURPHY:

* * *

Q What, if any, relevance to [sic] the separation stream lines shown in the sketch in the upper left-hand quadrant of the Dorsch—of the exhibit, KO,† have to the air flow pattern presented by the Dorsch device?

A Well, in the upper left-hand figure of KO, the release angle as shown as I believe 17 degrees—It's not marked on the figure, but it's shown as 17 degrees. The Dorsch device in none of its orientations has a release angle of 17 degrees.

Q If an aerodynamicist were to compare any of the drawings shown on Exhibit KO, or any of the sketches shown on Exhibit KO, to the aerodynamic concept set forth in the Dorsch patent as it relates to the orientation of the device viewed from the side of the device, to what portion of that exhibit would he direct his attention?

A My understanding of the Dorsch patent and what was being focused on was the—this part. It was the upper part of this hemispherical shell which is shown on the right side of KO.

The inventor wanted to present to the air flow a portion of a spherical shape so there would be—no vertical **[Tr. 4710]** part could form a region of stagnation and such that the air flow would remain attached and come off at a—with respect to the vertical, a large release angle.

Q Dr. Widnall, rather than marking in any way Defendant's Exhibit KO, I wonder if you would on the sketch pad make another sketch illustrating the point that you have just made. I have colored markers here. You can select what you wish.

A Draw it on top of a tractor?

---

† See Appendix N at A130.

Q Why don't you draw substantially the figure that was in the upper right-hand portion of KO?

A I know what it looks like. In the upper right-hand side of KO, there is a sketch of a hemispherical shape. That looks a little too elliptical, but I think that's good enough, and this is shown as having a release angle of 90 degrees and air flow going over like that.

Q Would you now mark on that exhibit [419]† in red the portion of the exhibit to which an aerodynamicist would direct attention insofar as you wish to compare it to the Dorsch shape?

A It would be a portion of this hemispherical arc. It would start somewhere at an angle of about 20 degrees, 15 to 20 degrees. This particular angle depends on pin settings. The actual angle that the device is oriented with **[Tr. 4711]** respect to the air flow depends on the particular pin settings of the device, but it's in this region. One would start at an angle of about 20 degrees and drop back through an angle of 34 degrees. Then the flow would then come off at a release angle.

* * *

Q And you simply sketched the separating flow at the release angle on the exhibit by a red arrow following the red line?

A Yes. Now, I think I should explain why this idea of taking a portion of the device is a reasonable thing to do with respect to its mountings on top of a trailer.

Q Would you explain that, please?

A Because it's certainly not obvious in a general case. You can take a part of a shape and stick it in a flow and somehow achieve a flow that has a relationship to what would have been obtained with the entire device. So I think I better talk about that a little bit.

This is basically related to what is called a principle of imaging in aerodynamics. **[Tr. 4712]**

Q Is that a recognized principle used by aerodynamicists?

A Yes. Let me draw it first with respect to trailer combination. If one wished to get some idea—and again, we are speaking of a complex flow and we are trying to abstract the essential

† See Appendix N at A129.

features from what is a complex flow. We are speaking of a device mounted on top of a trailer, something like this. I can't speak for any of the angles related to that curve with the air flow coming to this device; trying to get some idea of this aerodynamics, if it's mounted on the surface like this, it's a common practice in aerodynamics to consider that the effect of a flat surface on a device is as if there were an image device located on the other side of the flat surfaces. So that in this case where it's mounted on a flat surface, the flow would more nearly have the shape associated with a full object rather than just this little portion.

In other words, the installation itself provides the remainder of the shape, so that it's like a full curved shape.

I think I mentioned that the concept of imaging I think is also inherently contained in the Saunders patent.

Q Would you explain in what respect it appears there?

A With respect to the Saunders patent, imaging is a **[Tr. 4713]** useful concept whenever there is a center line or an apparent center line of the flow.

With respect to the Saunders patent, there is a line of symmetry in the flow and this disc cylinder combination was positioned about this line of symmetry, and in this case the stream lines come up like that, and with respect to the analogy between the disc cylinder combination and the trailer, the top of the tractor essentially is located—this line is analogous to this line, and it's only the upper half of this flow which is shown, and there is some sense the rest of the image located in the roof of the cab.

Q For the record, Dr. Widnall, would you take a colored marker and mark the portions of the exhibit to which you just referred, when you say this line is analogous to the other and describe it in the record so that the transcript will make it—

A I would say that in the cylinder disc experiments—Shall I draw the red line?

Q Yes.

A The red line in the cylinder disc experiment represents the center line of the experiment. In the application to the trailer combination, it's only the upper half of this curve—the upper

half of the sketch which is **[Tr. 4714]** used. The upper half of this sketch is analogous—

Q "This sketch" being the sketch of a cylinder which appears at the bottom of the drawing; is that correct?

A That's correct. The upper half of the sketch of the cylinder disc combination is analogous to that part of the trailer combination of both [sic] the red line.

Q Would you mark the portion, the upper portion of the disc cylinder with the letter "A"?

A Okay.

Q And the upper portion of the sketch of the trailer with the letter "B"?

A Okay.

Q So what you're saying for the record is that in utilizing the imaging concept as related to the Saunders, A would be analogized to B?

A That's right.

* * *

MR. MURPHY: May I have that exhibit marked, if Your Honor please, and I would offer it.

(Plaintiff's Exhibit No. 419 marked for **[Tr. 4715]** identification.)

MR. BRENEISEN: No objection.

(Plaintiff's Exhibit No. 419 marked in evidence. **[Tr. 4716]**

* * *

Excerpts from Plaintiffs' Trial Exhibit 118 (University of Maryland Wind Tunnel Report No. 98—Wind Tunnel Test of Trailmobile Trailers, 2nd Series)

* * *

During the period of October 12 through October 20, 1953, wind tunnel tests of 1/6 scale trailer models were conducted for Trailmobile Incorporated in the University of Maryland Wind Tunnel to measure the drag of various trailer fronts and to study the effect of streamlining the model upon drag reduction. Included were tests of trailer bodies with rounded front corners, various tractor-trailer spacings, post size, skirts, streamlined tractor and streamlined tail fairing for the trailer.

* * *

[p. 2 of exhibit]

The fairing from the cab to the trailer, as mentioned previously reduced the drag considerably. The design used on the model is not practical, but it is felt that a fairing approaching this type that does not actually attach to the trailer may not be unreasonable.

* * *

[p. 11 of exhibit]

Excerpts from Plaintiffs' Trial Exhibit 119 (University of Maryland Wind Tunnel Report No. 150—Wind Tunnel Tests of Trailmobile Trailers, 3rd Series)

* * *

Wind tunnel tests were conducted on several 1/6 scale model trailers for Trailmobile, Incorporated, at the University of Maryland Wind Tunnel on April 1, 1955. This was the third series of tests of these trailers.

* * *

[p. 2 of exhibit]

Excerpts from Plaintiffs' Trial Exhibit 162 (Prosecution History of the '876 Patent)

* * *

The air deflectors shown and described in Huet are essentially streamlined turning vanes mounted approximately parallel to the direction of motion of the vehicle. The air deflectors shown and described in the instant application are essentially flat plates attached to the tractor perpendicular to the direction of the motion of the vehicle.

* * *

Saunders' Response (at page 5) of February 25, 1965 to Patent Office rejection of October 28, 1964.

* * *

. . . the deflectors described in the instant application are essentially flat plates attached to the tractor at right angles to the direction of movement of the vehicle. These plates are shaped, dimensioned and located to deflect the air at a relatively large angle away from the periphery of the trailer, thereby creating a region of low pressure in front of the trailer.

* * *

Id. at page 8.

Docket Sheet Excerpts

Excerpts of United States District Court For The District of Connecticut Docket Sheets Showing All Entries From The Date The Judgments Were Entered on April 17, 1986 Through May 11, 1988.

Uniroyal, Inc. v. Rudkin Wiley Corporation
N-75-51

1986

* * *

4/17 JUDGMENT, entered. It is ORD., ADJ. and DEC. that jmt. is hereby entered in favor of the pltfs., Uniroyal, Inc. and Premix, Inc., and U.S. Patent 3,241,876, (the " '876 patent") be and is hereby declared invalid and not infringed. It is further ORD., ADJ. and DEC. that any and all counterclaims filed by Rudkin-Wiley in this cause are dismissed with prej. Rowe, C.
cc: attys. M4/86 lr

4/21 ENVELOPE containing end. on Mot to Amend Jmt. addressed to Mr. Langani, returned.

5/8 ENVELOPE containing JUDGMENT addressed to Mr. Langani, returned. cs.

5/16 NOTICE of Appeal filed by Rudkin-Wiley Corp. from Final Judgment. Copies C & D and Notice of Motion sent Atty. Carr. km

5/19 CERTIFIED copy of Notice of Appeal, Docket and receipt sent USCA. for the Federal Circuit. km

5/27 CERTIFICATE of Service, filed by Attorney Carr for Notice of Appeal. km

7/25 PLTF'S. MOT. on Consent for Removal of Photographic Materials, filed (cs)

7/28 END. on Plt's Mot. on Consent for Removal of Photographic Materials: Granted. Burns, J. cc:mailed. (fjc)

1988

1/15 MANDATE recv. from U.S. Ct. of App. for the Fed. Circuit (Wash.D.C.), Affirmed-in-Part, Reversed-in-Part, Vacated-in-Part and Remanded. km

Premix, Inc. v. Rudkin-Wiley Corporation
B-80-281

1986

* * *

4/17 JUDGMENT ent.: ORDERED, ADJUDGED and DECREED that jmt. be ent. in favor of the pltfs, Uniroyal, Inc. & Premix, Inc., & U.S. Patent 3,241,876, (the "876 patent") be & is hereby declared invalid & not infringed. It is further ORDERED, ADJUDGED and DECREED that any & all counterclaims filed by Rudkin-Wiley in this cause are dismissed w/ prej. ROWE, C., cc: counsel. (M-4/22/86) mh

5/16 NOTICE of Appeal filed by Rudkin-Wiley Corp. from Final Judgment.

5/19 CERTIFIED copy of Notice of Appeal, Docket and receipt sent USCA for the Federal Circuit.

7/25 PLTFS" Mot. on Consent for Removal of Photographic Materials, filed. (mh) 7/28 end.: "Granted." BURNS, J. orig EBB

Excerpts of the United States Court of Appeals for the Federal Circuit Docket Sheets Showing All Entries Under "Proceedings and Orders" from Filing Date through May 11, 1988.

Docket No. 86-1300

Date	PROCEEDINGS AND ORDERS
June 3, 1986	Received certified list. Notices sent to parties. pjt
	COUNSEL FOR THE APPELLANT/: Francis T. Carr
	MOB ☑ BAS ☐ _____
	COUNSEL FOR THE APPELLEE (Uniroyal): Thomas A. Beck
	MOB ☑ BAS ☐ _____
June 13, 1986	Certificate of Interest filed by the Appellant/
June 13, 1986	Certificate of Interest filed by the Appellee/ 8/2 (UNIROYAL & PREMIX, Inc.)
	COUNSEL FOR THE APPELLEE (PREMIX, INC.) Donald L. Otto
August 5, 1986	BRIEF/APPENDIX FOR APPELLANT, filed. (Separate Non-Confidential Joint Appendix, Vols. I-II (12 of each), Separate Confidential Joint Append Vol. III (5 copies), Separate Non-Confidential Joint Appendix (Exhibits) Vols. IV-V (4 of each), Separate Confidential Joint Appendix (Exhibits Vol. VI (4 copies)) (SD-8/4-H) (jb)
September 5, 1986	1. Appellees' consent motion for an extension of time (to and including September 22, 1986) to file their brief, filed. (SD-9/4-M) (ejc)

		(9/9/86) GRANTED: September 10, 1986. (per fxg) (ejc) (9/10/86)
September 22, 1986		BRIEF FOR THE APPELLEE, filed. (SD-9/22-H) (jb) (Uniroyal Inc.)
October 1, 1986	2.	Letter from appellant requesting this case be the first one scheduled because he needs to set up physical exhibits, received. (copies to fxg & bh) [10/3 df]
October 6, 1986	3.	Letter to counsel Carr, Beck & Otto re oral argument on Nov. 4/F. df
October 7, 1986		REPLY BRIEF FOR APPELLANT, filed. (SD-10/6-H) (jb)
November 4, 1986		Argued. (Davis, Newman, & Archer, JJ) lc
Jan. 13, 1988		AFFIRMED-IN-PART, REVERSED-IN-PART, VACATE-IN-PART AND REMANDED. Archer, J. "Judgment Entered" (scg)
Jan. 25, 1988	4.	Appellees' motion for a 30-day extension of time (to and including Feb. 26, 1988) to file its petition for rehearing, filed. (SD-1/22-M) (ejc) (EOD 1/26/88) GRANTED: 1/28/88. (per df at direction of GA) (ejc)
Jan. 27, 1988	5.	Appellant's motion for award of costs on appeal (with bill of costs attached), filed. (SD-1/26-M) (ejc) (EOD 1/28/88)
February 2, 1988	6.	Plaintiff-appellees, Uniroyal, Inc. and Premix, Inc.'s motion for stay of mandate pending petition for writ of certiorari, filed. (SD-2/1-M.(bam) (*See Order 2/8/88*)

February 5, 1988	7.	Appellees' opposition to appellant's motion for award of costs on appeal, filed. (SD-2/4-M) (ejc) (EOD 2/9/88)
February 5, 1988		PJT called counsel for appellees and requested 3 copies of their opposition to appellant's motion for award of costs.
February 8, 1988	8.	ORDER: IT IS HEREBY ORDERED that Plaintiffs-Appellees' motion for stay of mandate is hereby GRANTED until March 4, 1988. (per fxg 2/5/88)
February 8, 1988		MANDATE STAYED UNTIL MARCH 4, 1988. (ejc)
February 8, 1988		Rec'd 3 add'l copies of appellees' opposition to motion for award of costs. (ejc)
February 26, 1988		PETITION FOR REHEARING (WITH SUGGESTION), filed by appellee Uniroyal, Inc. (SD-2-26-H). SOP 16 circulated 2/26-88. mym DENIED: 3-31-88 SOP 18 circulated 3-31-88. mym 3-31-88 letter to appellant (Francis T. Carr) requesting response to Uniroyal's suggestion for rehearing in banc. Response due 4-14-88. Response due 4/21/88 (see entry #11/df) Response received 4-21-88 (SD-4-21-H). SOP 18 (response) circulated 4-22-88. DECLINED: 5-10-88
April 4, 1988	9.	Appellee's motion to stay mandate (until May 9, 1988), filed. (SD-4-4-M) pjt to fg (SEE ORDER DATED 4/11/88).(bam)

April 7, 1988	10. Opposition of appellant to motion for stay of mandate pending petition for writ of certiorari, filed. (SD-4/6/88-M) (df) (SEE ORDER DATED 4/11/88).(bam)
April 7, 1988	11. Letter of appellant confirming an extension of time to file response to suggestion for rehearing in banc was granted by the clerk verbally to April 21, 1988, received. (df)
April 11, 1988	12. IT IS ORDERED: Appellees' motion for stay of mandate is hereby GRANTED to the extent that the mandate will issue 30 days from issuance of this order. (per fxg on 4/8/88).(bam)
May 6, 1988	13. Appellees' motion for stay of mandate pending petition for writ certiorari (30 days from May 11, 1988), filed. (SD-5/6-M). (bam) DENIED: 5/11/88. (per fxg on 5/10/88).(bam)

A True Copy.

Attest: 5-12-88

JAMES BENJAMIN

Deputy Clerk

Rudkin-Wiley Notice Under Fed. R. App. P.

KENYON & KENYON

[Letterhead]

Felfe & Lynch: Received July 7, 1986

July 1, 1986

VIA TELECOPIER (Confirmation By Mail)

Thomas A. Beck, Esq.
Felfe & Lynch
805 Third Avenue
New York, New York

Re: Rudkin-Wiley v. Uniroyal, Premix

Dear Tom:

Further to our letter of June 6, 1986, transmitted herewith are Rudkin-Wiley's appendix designations.

The issues Rudkin-Wiley shall present for review are: (1) the validity of the Saunders Patent under 35 U.S.C. § 103; (2) infringement of the Saunders Patent by Uniroyal and Premix; and (3) the willfulness of that infringement.

Please let us have your counter-designations, if any, as promptly as possible so that we can commence preparation of the appendix.

Very truly yours,

KENYON & KENYON

JOHN D. VANDENBERG
John D. Vandenberg

JDV/ec

cc: (w/enc.) William R. Murphy, Esq.
" Donald L. Otto, Esq.
" Albert J. Breneisen, Esq.

Statutes

35 U.S.C. § 103 (1982 and Supp III 1986)

§ 103. Conditions for patentability; non-obvious subject matter

A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

Subject matter developed by another person, which qualifies as prior art only subsection (f) or (g) of section 102 of this title, shall not preclude patentability under this section where the subject matter and the claimed invention were, at the time the invention was made, owned by the same person or subject to an obligation of assignment to the same person.

28 U.S.C. § 1254

§ 1254. Courts of appeals; certiorari; appeal; certified questions

Cases in the courts of appeals may be reviewed by the Supreme Court by the following methods:

(1) By writ of certiorari granted upon the petition of any party to any civil or criminal case, before or after rendition of judgment or decree; . . . .

COURT RULES

FEDERAL RULES OF APPELLATE PROCEDURE

Rule 10. The Record on Appeal

(a) Composition of the Record on Appeal. The original papers and exhibits filed in the district court, the transcript of proceedings, if any, and a certified copy of the docket entries prepared by the clerk of the district court shall constitute the record on appeal in all cases.

(b) The Transcript of Proceedings; Duty of Appellant to Order; Notice to Appellee if Partial Transcript is Ordered.

(1) Within 10 days after filing the notice of appeal the appellant shall order from the reporter a transcript of such parts of the proceedings not already on file as the appellant deems necessary, subject to local rules of the courts of appeals. The order shall be in writing and within the same period a copy shall be filed with the clerk of the district court. If funding is to come from the United States under the Criminal Justice Act, the order shall so state. If no such parts of the proceedings are to be ordered, within the same period the appellant shall file a certificate to that effect.

(2) If the appellant intends to urge on appeal that a finding or conclusion is unsupported by the evidence or is contrary to the evidence, the appellant shall include in the record a transcript of all evidence relevant to such finding or conclusion.

(3) Unless the entire transcript is to be included, the appellant shall, within the 10 days time provided in (b)(1) of this Rule 10, file a statement of the issues the appellant intends to present on the appeal and shall serve on the appellee a copy of the order or certificate and of the statement. If the appellee deems a transcript or other parts of the proceedings to be necessary, the appellee shall, within 10 days after the service of the order or certificate and the statement of the appellant, file and serve on the appellant a designation of additional parts to be included. Unless within 10 days after service of such designation the appellant has ordered such parts, and has so notified the appellee, the appellee may within the following 10 days either order the parts or move in the district court for an order requiring the appellant to do so.

(4) At the time of ordering, a party must make satisfactory arrangements with the reporter for payment of the cost of the transcript.

* * * *

(d) Agreed Statement as the Record on Appeal. In lieu of the record on appeal as defined in subdivision (a) of this rule, the parties may prepare and sign a statement of the case showing how the issues presented by the appeal arose and were de-

cided in the district court and setting forth only so many of the facts averred and proved or sought to be proved as are essential to a decision of the issues presented. If the statement conforms to the truth, it, together with such additions as the court may consider necessary fully to present the issues raised by the appeal, shall be approved by the district court and shall then be certified to the court of appeals as the record on appeal and transmitted thereto by the clerk of the district court within the time provided by Rule 11. Copies of the agreed statement may be filed as the appendix required by Rule 30.

(e) Correction or Modification of the Record. If any difference arises as to whether the record truly discloses what occurred in the district court, the difference shall be submitted to and settled by that court and the record made to conform to the truth. If anything material to either party is omitted from the record by error or accident or is misstated therein, the parties by stipulation, or the district court either before or after the record is transmitted to the court of appeals, or the court of appeals, on proper suggestion or of its own initiative, may direct that the omission or misstatement be corrected, and if necessary that a supplemental record be certified and transmitted. All other questions as to the form and content of the record shall be presented to the court of appeals.

Rule 11. Transmission of the Record

* * *
* * *
* * *
* * *

(e) Retention of the Record in the District Court by Order of Court. The court of appeals may provide by rule or order that a certified copy of the docket entries shall be transmitted in lieu of the entire record, subject to the right of any party to request at any time during the pendency of the appeal that designated parts of the record be transmitted.

If the record or any part thereof is required in the district court for use there pending the appeal, the district court may make an order to that effect, and the clerk of the district court

shall retain the record or parts thereof subject to the request of the court of appeals, and shall transmit a copy of the order and of the docket entries together with such parts of the original record as the district court shall allow and copies of such parts as the parties may designate.

* * *
* * *

Rule 30. Appendix to the Briefs

(a) Duty of Appellant To Prepare and File; Content of Appendix; Time for Filing; Number of Copies. The appellant shall prepare and file an appendix to the briefs which shall contain: (1) the relevant docket entries in the proceeding below; (2) any relevant portions of the pleadings, charge, findings or opinion; (3) the judgment, order or decision in question; and (4) any other parts of the record to which the parties wish to direct the particular attention of the court. Except where they have independent relevance, memoranda of law in the district court should not be included in the appendix. The fact that parts of the record are not included in the appendix shall not prevent the parties or the court from relying on such parts.

Unless filing is to be deferred pursuant to the provisions of subdivision (c) of this rule, the appellant shall serve and file the appendix with the brief. Ten copies of the appendix shall be filed with the clerk, and one copy shall be served on counsel for each party separately represented, unless the court shall by rule or order direct the filing or service of a lesser number.

(b) Determination of Contents of Appendix; Cost of Producing. The parties are encouraged to agree as to the contents of the appendix. In the absence of agreement, the appellant shall, not later than 10 days after the date on which the record is filed, serve on the appellee a designation of the parts of the record which the appellant intends to include in the appendix and a statement of the issues which the appellant intends to present for review. If the appellee deems it necessary to direct the particular attention of the court to parts of the record not designated by the appellant, the appellee shall, within 10 days after receipt of the designation, serve upon the appellant a designa-

tion of those parts. The appellant shall include in the appendix the parts thus designated. In designating parts of the record for inclusion in the appendix, the parties shall have regard for the fact that the entire record is always available to the court for reference and examination and shall not engage in unnecessary designation.

Unless the parties otherwise agree, the cost of producing the appendix shall initially be paid by the appellant, but if the appellant considers that parts of the record designated by the appellee for inclusion are unnecessary for the determination of the issues presented the appellant may so advise the appellee and the appellee shall advance the cost of including such parts. The cost of producing the appendix shall be taxed as costs in the case, but if either party shall cause matters to be included in the appendix unnecessarily the court may impose the cost of producing such parts on the party. Each circuit shall provide by local rule for the imposition of sanctions against attorneys who unreasonably and vexatiously increase the costs of litigation through the inclusion of unnecessary material in the appendix.

RULES OF THE UNITED STATES COURT OF APPEALS FOR THE FEDERAL CIRCUIT

Rule 11 Record on Appeal; Transmission of Docket Entries or Certified List; Docketing

(a) *General.*

(1) *Composition of Record.* The record on appeal shall consist of those papers named in FRAP 10(a) and 16.

* * *

(4) *Retention of Record.* All papers shall be retained by the tribunal from which appeal is taken, as provided in FRAP 11(e) and 17(b). When deemed necessary, the original or certified copies of the trial or administrative record, or portions thereof, may be ordered by this court, on motion or sua sponte, at any time during pendency of the appeal.

FEDERAL RULES OF CIVIL PROCEDURE

Rule 52. Findings by the Court.

(a) Effect. In all actions tried upon the facts without a jury or with an advisory jury, the court shall find the facts specially and state separately its conclusions of law thereon, and judgment shall be entered pursuant to Rule 58; and in granting or refusing interlocutory injunctions the court shall similarly set forth the findings of fact and conclusions of law which constitute the grounds of its action. Requests for findings are not necessary for purposes of review. Findings of fact, whether based on oral or documentary evidence, shall not be set aside unless clearly erroneous, and due regard shall be given to the opportunity of the trial court to judge of the credibility of the witnesses. The findings of a master, to the extent that the court adopts them, shall be considered as the findings of the court. It will be sufficient if the findings of fact and conclusions of law are stated orally and recorded in open court following the close of the evidence or appear in an opinion or memorandum of decision filed by the court. Findings of fact and conclusions of law are unnecessary on decisions of motions under Rules 12 or 56 or any other motion except as provided in Rule 41(b).

Designation of Corporate Relationships Pursuant to Sup. Ct. R. 28.1

Uniroyal, Inc., filing this *Petition For a Writ of Certiorari To The United States Court of Appeals For The Federal Circuit*, pursuant to Sup. Ct. R. 28.1, as appellant in this proceeding states that:

A. this is the original Designation of Corporate Relationships.

B. Uniroyal, Inc. is now dissolved; however at the time this action was brought it was not owned by a parent corporation.

C. Uniroyal, Inc. does not have an ownership interest in any subsidiaries.

D. Uniroyal, Inc. does not have any affiliates.

Premix, Inc. filing this *Petition For a Writ of Certiorari To The United States Court of Appeals For The Federal Circuit*, pursuant to Sup. Ct. R. 28.1, as petitioner in this proceding states that:

A. this is the original Designation of Corporate Relationships for Premix, Inc.

B. Premix, Inc. is not owned by any parent corporation.

C. Premix EMS, Inc. is the subsidiary of Premix, Inc. Premix, Inc. does not have any ownership interest in any other subsidiaries.

D. Premix, Inc. does not have any affiliates.

PURSUANT TO SUP. CT. R. 33.1(d)
APPENDICES J THROUGH N ARE BEING FILED IN
A SEPARATE VOLUME
CONTEMPORANEOUS WITH PETITION

EDITOR'S NOTE

THE FOLLOWING PAGES WERE POOR HARD COPY AT THE TIME OF FILMING. IF AND WHEN A BETTER COPY CAN BE OBTAINED, A NEW FICHE WILL BE ISSUED.

Supreme Court, U.S.
FILED
JUN 14 1988
JOSEPH F. SPANIOL, JR.
CLERK

No.

IN THE
Supreme Court of the United States
OCTOBER TERM, 1987

UNIROYAL, INC.,
Petitioner,
—v.—
RUDKIN-WILEY CORPORATION,
Respondent.

PREMIX, INC.,
Petitioner,
—v.—
RUDKIN-WILEY CORPORATION,
Respondent.

APPENDICES J THROUGH N TO PETITION FOR WRIT OF CERTIORARI

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Attorneys for Petitioners

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APPENDIX J

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U.S. Patent 3,241,876 to Saunders A93-A99

March 22, 1966 W. S. SAUNDERS 3,241,876

APPARATUS FOR REDUCING LINEAR AND LATERAL WIND RESISTANCE IN A TRACTOR-TRAILER COMBINATION VEHICLE

Filed Jan. 31, 1964 3 Sheets-Sheet 1

FIG. 1

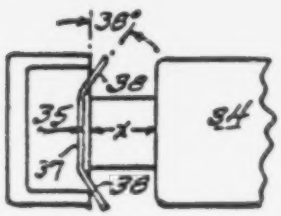


FIG. 2

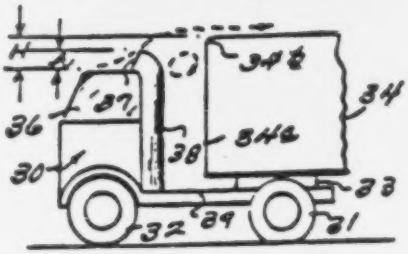


FIG 3

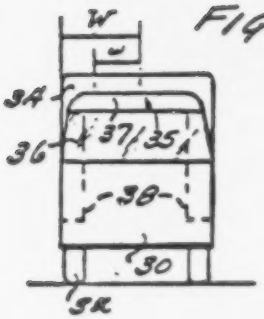


FIG 4

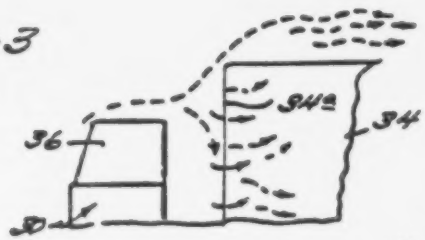


FIG 5

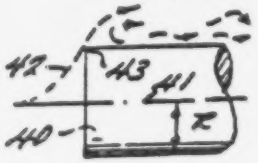


FIG 6

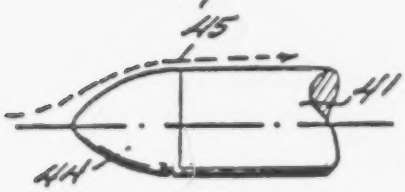


FIG 7

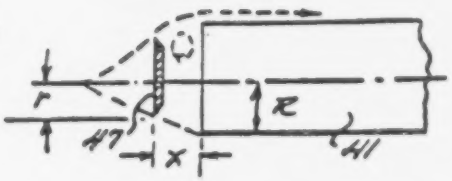


FIG 8

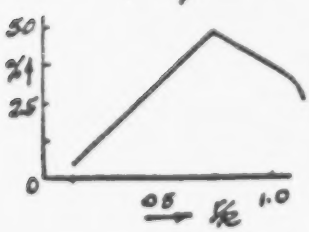
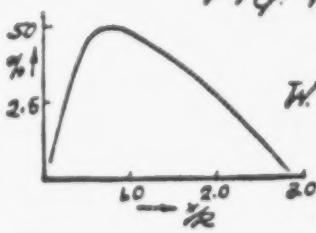


FIG 9



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March 22, 1966 W. S. SAUNDERS 3,241,876

APPARATUS FOR REDUCING LINEAR AND LATERAL WIND RESISTANCE IN A TRACTOR-TRAILER COMBINATION VEHICLE

Filed Jan. 31, 1964 3 Sheets-Sheet 3

FIG. 11

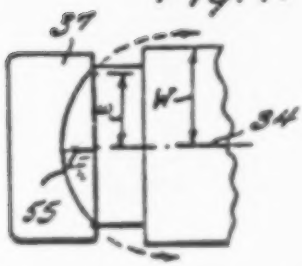


FIG. 10

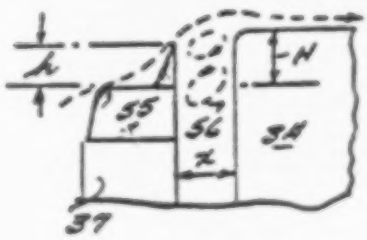


FIG. 12

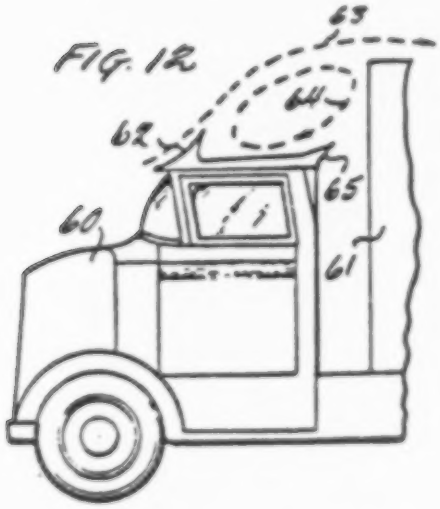


FIG. 13

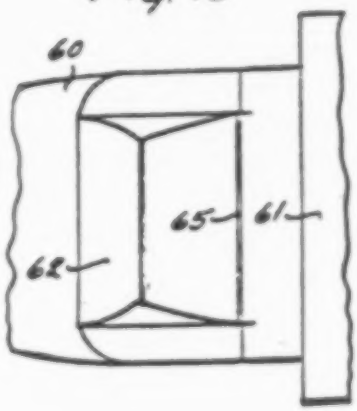


FIG. 14

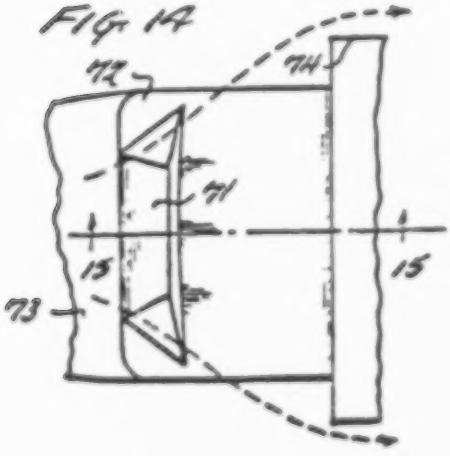
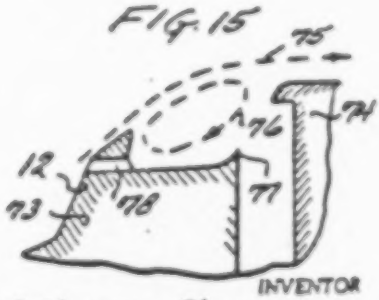


FIG. 15



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March 22, 1966 W. S. SAUNDERS 3,241,876

APPARATUS FOR REDUCING LINEAR AND LATERAL WIND RESISTANCE IN A TRACTOR-TRAILER COMBINATION VEHICLE

Filed Jan. 31, 1964 3 Sheets-Sheet 3

FIG. 16

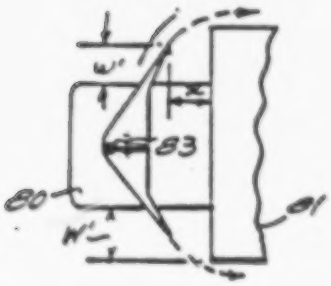

FIG. 17

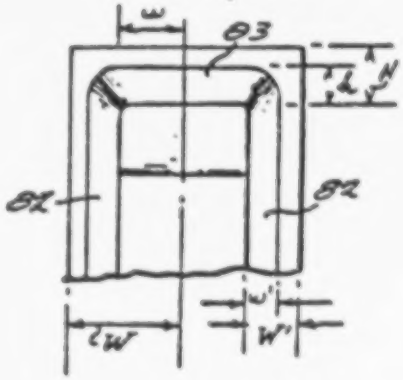

FIG. 18

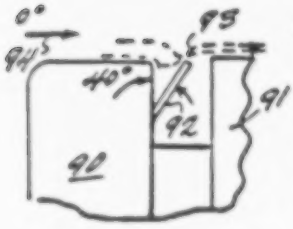

FIG. 19

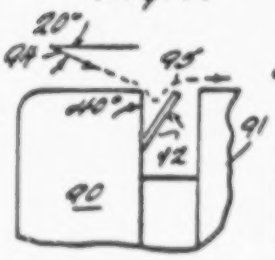

FIG. 20

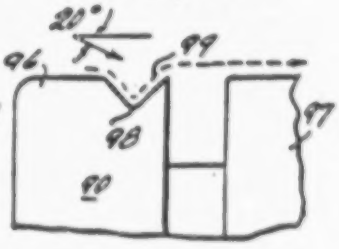

FIG. 21

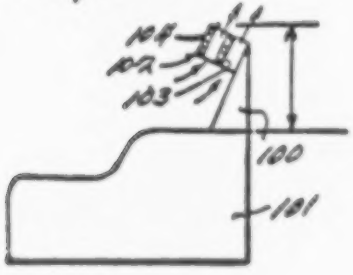

FIG. 22

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United States Patent Office 3,241,876
Patented Mar. 22, 1966

3,241,876
APPARATUS FOR REDUCING LINEAR AND LATERAL WIND RESISTANCE IN A TRACTOR-TRAILER COMBINATION VEHICLE

Walter Selden Saunders, 8014 Bradley Blvd., Bethesda, Md.

Filed Jan. 31, 1964, Ser. No. 341,622
4 Claims. (Cl. 296—1)

This invention relates to apparatus for reducing the wind resistance or drag effecting the linear movement of a tractor-trailer combination, as well as reducing the yaw or side sway occasioned by a cross wind, and constitutes a continuation-in-part of my copending application Serial No. 215,424, now abandoned, filed August 7, 1962, entitled, Device to Reduce the Air Resistance of Trucks.

A primary object of this invention is the provision of apparatus adapted to be connected or attached to a tractor or trailer in a combination vehicle which will effectively reduce the wind resistance to forward movement, or drag thereof.

A further object of the invention is the provision of apparatus of this character which will also effectively reduce the side sway or yaw of such a combination vehicle as effected by a transverse or cross wind during the forward travel of the vehicle.

An additional object of the invention is by reducing the resistance of drag and yaw to reduce fuel consumption, diminish driver fatigue, and enhance dynamic stability on the road, as well as to accelerate the speed of transit of the vehicle.

Still another object of the invention is the provision of a device of this character which will operate in a manner different from that of previous devices which contemplate similar results, in that, rather than streamlining the vehicle body, either the tractor or trailer, to afford a smooth and uniform air flow, thus creating a difficult manufacturing problem, as well as reducing the body capacity of the vehicle, the device of the instant invention produces a relatively wide diffusion of the air impacting the forward portion of the trailer, and causes the same to readhere to the body of the truck rearwardly of the front portion thereof in a relatively smooth and even manner, while at the same time creating a low pressure area or bubble between the tractor and the front of the trailer, so that the trailer will, in effect, be pushing forward against reduced rather than increased resistance.

As conducive to a clearer understanding of this invention, it may here be pointed out that applicant is aware that various methods have heretofore been proposed for reducing the drag of vehicles of this nature. Such methods have, however, followed conventional streamlining techniques, a streamlined body being generally considered to be one in which the flow experiences minimum separation from the surface of the body. Since a trailer truck is not a streamlined body, because the flow will normally separate from all of the relatively sharp edges of the truck, such conventional techniques have been uniformly unsatisfactory. The conventional streamlining techniques heretofore applied have attempted to minimize the forward separation of air by either rounding the forward corners of the truck, employing streamlining vanes or guide vanes to keep the air separation to a minimum, or enclosing the tractor-trailer gap with some form of fairing. The instant invention, which is concerned only with the drag arising from the separation occurring at the forward portions of the truck and not with drag due to separation at the rear of the trailer, differs from the above in that there is employed a deflecting device mounted on the tractor which deflects the onrushing air in such manner as to occasion a very large separation of the air flow.

This deflection is made to occur, however, in such fashion that the flow moves convexly across the gap between the tractor and trailer and reattaches to the forward periphery of the trailer. This separation causes a low pressure bubble to be formed in the gap between the tractor and trailer, and although a large separated region exists, the flow pattern which is set up results in a very material drag reduction due to the lowered resistance encountered by the forward portion of the trailer. As expected, such a deflector added to a tractor alone will increase its drag, but the drag of the combination is significantly and unexpectedly reduced. It is a primary object of this invention therefore to provide an attachment which produces a material reduction in the drag of a trailer-tractor combination, and the consequent inherent benefits of such reduction, in accordance with the principles outlined above

Still other objects reside in the combinations of elements, arrangements of parts, and features of construction, all as will be more fully pointed out hereinafter and disclosed in the accompanying drawings.

In the drawings:

FIGURE 1 is a partially schematic and partially broken away top plan view of a tractor-trailer combination provided with a deflector or shield in accordance with a preferred embodiment of the instant invention, parts thereof being broken away.

FIG. 2 is a side elevational view of the portions of the vehicle schematically shown in FIG. 1.

FIG. 3 is a front elevational view of the structure of FIGS. 1 and 2.

FIG. 4 is a diagrammatic fragmentary side elevational view illustrating the turbulent air flow of a conventional tractor-trailer combination vehicle without the deflector of the instant invention.

FIG. 5 is a diagrammatic view illustrating the flow pattern of air over a cylinder whose axis is parallel to the direction of the flow.

FIG. 6 is a similar view of the flow pattern which occurs when the cylinder of FIG. 5 is shielded by a typical streamlined fairing or nose cone.

FIG. 7 is a similar view which discloses the flow pattern when the cylinder of FIG. 5 is shielded by a disk, illustrating the principles of the instant invention.

FIG. 8 is a graph disclosing the percent of drag reduction for the cylinder and disk of FIG. 7 over that of the cylinder of FIG. 5 for various ratios r/R, where r represents the radius of the disk and R the radius of the cylinder.

FIG. 9 is a graphic representation of the percentage of drag reduction for a cylinder and disk in accordance with FIG. 7 over the cylinder of FIG. 5 for various ratios of x/R where x is the distance of the shield from the end of the cylinder and R is the radius of the cylinder.

FIG. 10 is a schematic side elevational view of a modified form of deflector in accordance with the construction of FIG. 1 omitting the side shields.

FIG. 11 is a top plan view of the structure of FIG. 10.

FIG. 12 is a side elevational view of a modified form of deflector shown as applied to the roof of a tractor unit omitting the side deflector plates for the control of yaw.

FIG. 13 is a top plan view of the deflector of FIG. 12.

FIG. 14 is a top plan view of a modified form of construction.

FIG. 15 is a sectional view taken substantially along the line 15—15 of FIG. 14.

FIG. 16 is a top plan view of a further modified form of deflector adapted to be employed when the tractor is narrower than the trailer and including the side deflector shields.

FIG. 17 is a schematic front elevational view of the shield and tractor cab of FIG. 16, parts thereof being broken away.

A 97

FIG. 18 is a top plan view of a portion of a tractor-trailer unit illustrating diagrammatically a completely masked shield and indicating the air flow when the relative wind is dead ahead.

FIG. 19 is a view similar to FIG. 18 but disclosing the change in air flow effected by a masked shield at large angles of yaw.

FIG. 20 is a view similar to FIG. 18 but disclosing a masked side shield constructed integrally with the tractor body.

FIG. 21 is a schematic side view of a conventional tractor cab provided with a shield in accordance with the instant invention, illustrating the employment of a series of turning vanes to augment the action of the deflector of the instant invention.

FIG. 22 is a fragmentary view showing a deflector vane associated with a box on the top of a tractor roof.

Similar reference characters refer to similar parts throughout the several views of the drawings.

Having reference now to the drawings in detail, and more particularly to FIGS. 1, 2 and 3, there is herein shown a preferred embodiment of the inventive concept as applied to a tractor-trailer combination wherein the height of the tractor cab is substantially less than the height of the trailer, but the width is substantially the same, as frequently occurs under present-day conditions. The tractor is generally indicated at 30, and includes in addition to the usual driving and steering wheels 31 and 32, a fifth wheel assembly 33 upon which the forward end of the trailer 34 is mounted in conventional fashion. The instant invention comprises a plate or deflector generally indicated at 35 mounted on the roof of the cab 36 of the tractor, and at a predetermined distance from the normal forward end 34a of the trailer. The shield includes a central portion 37 which is inclined upwardly and rearwardly toward the front of the trailer, and a pair of rearwardly inclined opposite side portions 38, which extend the full height of the body of the tractor above its bed or frame 39. It has been determined by experimentation, as will be more fully described hereinafter, that the height of the shield 35 and its distance from the forward end of the trailer determine to a large extent the effectiveness of the shield in decreasing drag or wind resistance. As shown in FIG. 4, in a tractor-trailer combination dimensioned in accordance with that disclosed in FIGS. 1 to 3, but without the provision of a shield such as disclosed, the air flowing over the forward end of the cab is deflected to a minor extent and impinges directly on the flat front surface of the trailer. This creates a marked increase in wind resistance in the gap between the tractor and trailer and sends air, as indicated by the arrows in FIG. 4, in a highly turbulent condition about the sides and over the top of the vehicle. With a top shield constructed in accordance with the instant invention the air flow follows the course of the arrows in FIG. 2, being deflected upwardly to a distance above the sharp corner 34b at the top of the trailer and then reattaching itself smoothly to the top surface at a position beyond the abrupt juncture. This smooth air flow creates a reduction in pressure in the space between the rear of the tractor and the front of the trailer, and such air as flows into this area circulates, as indicated diagrammatically in FIG. 2, in reduced pressure eddies. In consequence the forward end of the trailer is travelling against a reduced pressure area, and a material reduction in drag is thus effectuated.

The side shields 38 offer little or no resistance to the forward passage of the tractor when travelling directly into the wind, or when the only wind pressure is occasioned by velocity, and serve to prevent the influx of air around the sides of the rear of the tractor into the gap between the tractor and trailer wherein the reduced pressure air circulates in eddies. The primary function of the side plates is, however, to preclude the entrance of air into the gap under those conditions wherein the

direction of travel of the vehicle is angular to the direction of the wind. Under such wind conditions air impinging against the front of the trailer has frequently materially increased the normal yaw or side sway of the trailer to a point of danger. As will be more fully pointed out hereinafter, the provision of the angularly and rearwardly extending baffles reduces to a material extent the yaw and drag produced by a cross wind.

The relation of the height of the shield or baffle to the difference in height between the roof of the tractor and the roof of the trailer as well as the distance of the deflector from the front of the trailer constitute an important feature in deriving optimum results. Extensive wind tunnel tests have resulted in the derivation of an empirical formula for the proper determination of this height and width. Such tests have been conducted primarily with a cylinder, as shown in FIG. 5 at 40, in a wind tunnel. In FIG. 4 with the center line of the cylinder as shown at 41 there is disclosed an example of the drag arising from the separation of the flow from the forward portion, the separation arising as at 42, and separating at the sharp edge 43 of the cylinder face creating a turbulent wake along the sides of the cylinder and resulting in an extremely large drag. This reaction is comparable to and typical of the forward face of a trailer vehicle in motion. If a rounded nose cone 44 is added to the cylinder 41 as shown in FIG. 6 providing a conventional streamlined nose, the separation of the flow is prevented and a relatively smooth air flow as indicated at 45 is provided materially reducing the drag. FIG. 7 discloses schematically the theory of applicant's invention which constitutes the provision of a baffle, or deflector 47, in this case in the form of a disk in front of the cylinder. Disks of different radii r were positioned at different distances x in front of the cylinder and tested in an open jet wind tunnel. The results are disclosed in the graph of FIG. 8 wherein the percentage of drag reduction of the combination of cylinder and disk over the cylinder alone is plotted versus the ratio r/R where R is the radius of the cylinder. FIG. 9 is a similar graph plotted in variations of the distance x between the disk and the cylinder face in relation to R, the radius of the cylinder. By means of these tests it was discovered that a maximum drag reduction of approximately fifty percent is achieved when r/R equals 0.7 and x/R equals 0.7. This drag reduction is very slightly less than that measured with the nose cone of FIG. 6 and represents a substantial drag reduction. The application of the knowledge gained by such tests and the application thereof to devices for the reduction of drag in tractor-trailer combination vehicles in such cases where a conventional nose cone or fairing is not practical constitutes a primary element of the instant inventive concept. Rather than preventing the separation of the streamline by a round nose cone of conventional type, the addition of a large deflecting disk or shield forces a wide separation of the air approaching the cylinder but the position and angle of the streamline are fixed in such a way that the flow curves convexly over the gap between the disk and the cylinder, or, alternatively, between the tractor and the trailer, and reattaches to the periphery of the cylinder or sides of the truck in substantially parallel relation to its sides. The interior of the gap between the two elements is at relatively low average pressure and is filled with quasi-stable eddies or bubbles as indicated in FIG. 7 and again in FIG. 2. Although these eddies exist, there is no violent interaction with the flow around the body and no violent wake is produced, and although a large region of separated flow exists, the drag remains relatively low.

The application of these principles to a deflecting device attached to a tractor as in FIG. 1 is further illustrated in FIGS. 10 and 11. Here a deflector 55 in general similar to the portion 37 of the deflector 35 is mounted on the top of a tractor which is spaced a distance x from a trailer 34. The difference in height between the roof of

the tractor and that of the trailer is indicated by H, while the height of the shield constructed in accordance with the previously derived shield is indicated by *h*. The arcuate deflector 55 which is inclined rearwardly forces the air out of its usual path before it reaches the gap region. The flow then curves convexly back across the gap and reattaches to the periphery of the trailer in a direction which is substantially parallel to the sides and top of the trailer. The gap is filled with quasi-stable eddies 56 as previously indicated in connection with FIG. 2, which eddies are isolated from the main flow and at relatively low pressure. The situation is substantially identical to that described in connection with FIG. 7. The baffle or deflector 55 and the air deflected thereby form a shield which precludes the relative wind from striking the front of the trailer and entering the gap between the tractor and trailer. Similarly, a region of low pressure is created in the gap and the trailer thus follows the tractor in a partial vacuum materially reducing the overall drag and rendering the unit more stable. In computing the height of the shield as used on the roof of the truck as shown in FIGS. 10 and 11 with the shield having a half width *w* and a height *h* and spaced as previously stated a distance *x* from the trailer it has been found that by employing the empirical formula previously discussed, that W corresponds to R and that the curves of FIGS. 8 and 9 depict the approximate variation of the drag reduction within the parameter previously defined. Thus a maximum drag reduction is obtained when x/W equals 0.7 and w/W equals 0.7. Applying the formula r/R to the height of the shield and substituting therefor h/H a curve similar to FIG. 8 is produced so that when *h* equals 0.7H a maximum drag reduction is achieved.

As shown in FIG. 8, effective, though not optimum results may be obtained when the height ratio of the shield or h/H is between 0.5 and 0.9. Similarly, as shown in FIG. 9, a wide variance in the ratio of the distance of the shield or baffle from the front of the trailer, or w/W is effective, though in progressively decreasing increments, over a range between 0.3 and about 2.0.

The frontal shape of the shield may vary, and it has been found advantageous to round the corners of the shield with a radius of about $\frac{1}{5}h$, although the rounded corners are not essential to the achievement of material drag reduction with the shield in the instant invention. FIGS. 12 and 13 disclose a modified form of shield embodying the basic inventive concept but which is more adapted to use where the relative gap between the tractor 60 and the trailer body 61 is relaitvely small. Here a shield or baffle 62 is provided on the forward edge of the roof of the trailer cab to deflect the main stream of air upwardly as at 63 and over the roof of the trailer while turning back a portion thereof to form an eddy or bubble 64 which serves further to deflect air from the front of the trailer 61, reducing the drag of the combination. A lip 65 may be provided at the rear of the cab roof which serves to assist in retaining the eddy 6 and in preventing further interchange between the outside air and the air in the gap between the rear of the tractor and the trailer.

FIGS. 14 and 15 disclose a further modification of the structure of FIGS. 12 and 13 wherein a shield 71 is provided adjacent the forward edge of the cab 72 of a tractor 73, which is provided with a trailer 74. Here the air flow 75 is similar to that shown at 63 in FIG. 12 and an eddy 76 is provided. A lip 77 corresponds to the lip 65. However, in this modification the shield is provided with a slot 78, which allows a second current of air to flow along the roof and over the lip 77, which further stabilizes the bubble 76 and precludes the entrance of air into the gap between the tractor and trailer.

If a cross wind is blowing over the road the vehicle is traversing, a relative wind at an angle of yaw as great as or sometimes greater than twenty degrees may be encountered. At a large angle of yaw the shield or deflector loses a certain amount of its ability to deflect the air around the windward side of the trailer and a material quantity of wind enters the gap between the tractor and trailer to increase the drag. This may be countered to some extent by extending the top shield to its legal limit, that is where w/W equal 1, but this reduces the performance when the wind is dead ahead. A consideration of FIG. 8 discloses that the peak showing the percent of drag reduction x/R and therefore x/W is not as sharply peaked as that for h/H. The center of the shield may be therefore moved forwardly on the tractor roof without seriously affecting its ability to reduce the drag at a zero angle of yaw. This change in shape, however, increases the deflection on the windward side up to a large angle of yaw and therefore an increase in w/W is not necessary. The curvature of shield 55 accomplishes this to some extent. Although the shield now resembles a wrap-around windshield for a conventional vehicle, and has a pleasing appearance, its opertaion is exactly the opposite of that of a wrap-around windshield in that the curved and slanted windshield keeps the separation to a minimum while the deflecting shield 55 is shaped so as to provide a separation of the flow in accordance with the precepts of the instant invention.

The flow of air around the sides of the truck behaves in a manner similar to that over the top, obviously, and in cases where the tractor vehicle 80, as shown in FIGS. 16 and 17, is materially narrower than that of the trailer 81, a shield 82 is provided along each edge of the cab extending downwardly from a central forwardly peaked top shield 83. It has been determined that the distance w'/W' equals 0.7 where w' equals the extension of the shield beyond the edge of the tractor and W' equals the width of extension of the trailer beyond the side of the tractor most advantageous results are provided. The side edges 82 preferably extend beyond the ends of the top shield 83 and should be merged in a smooth curve as shown in FIG. 17. Such side shields can be extended rearwardly as shown in FIG. 16 and should be located as close as possible to the trailer while still allowing a ninety degree maximum rotation of the tractor and a four inch minimum clearance space between the tractor and trailer at any angle of rotation. Preferably the side shields are slanted back to a material extent.

A material improvement in performance is effected by the structure of FIG. 1 when, if the tractor is sufficiently wide, its body may be used to mask a portion of the side shield when the wind is dead ahead. In this case a side shield may be used which is large enough to give a very material drag reduction at large angles of yaw, but which will be completely masked so that the zero yaw performance when the wind is head ahead is completely unaffected. The preferred embodiment of the invention as shown in FIG. 1 incorporates such a principles which is further schematically illustrated in FIGS. 18 and 19. Here the tractor vehicle 90 is provided in the gap between it and its associated trailer 91 with a vertically positioned deflector plate 92. The preferred angle of declination to the rear has been found by experiment to be approximately forty degrees, as illustrated also in FIG. 1. When the wind is dead ahead or the yaw angle is zero as illustrated at 94, the air flow is indicated at 93, the shield having thus virtually no effect on the drag of the vehicle. However, when a cross wind is blowing and the angle of yaw is twenty degrees or less as shown at 94 in FIG. 19, the air flow path is indicated at 95, where the air flowing sharply around the rear corner of the tractor is deflected by the shield 92 in a manner similar to that previously described, and passes smoothly along the sides of the trailer, being completely excluded from the gap therebetween.

A modification of this principle is shown in FIG. 20 which discloses schematically the top of a tractor 96 and its associated trailer 97 having a gap therebetween wherein the side of the tractor is formed with a vertical recess 98, which deflects the air path at 99 away from the gap between the tractor and trailer in substantially the same manner as the shield 92 previously described.

Such side shields and/or masked side shields may be also advantageously employed between two trailers which are connected in a train, or in any surface in which there exists a gap. Preferably the masked side shields merge smoothly with the roof shield as shown in the embodiment of FIGS. 1, 2 and 3.

Under certain circumstances where, for example, it is necessary to keep the deflector height as low as possible, a deflector with an actual height h less than 0.7H may be built to accomplish a very material flow reduction. Such a modified form of the invention is disclosed in FIG. 21 wherein a deflector 100 is mounted on the roof of a tractor 101 followed by the usual trailer, and wherein the height of the deflector h' is equal to substantially 0.5H where H is the height of the trailer. In this case a box-like structure 102 is provided at the top forward face of the shield 100 containing parallel deflector plates 103 and its face plate 104. By this means a total deflection large enough to produce a flow that will attach to the following body and form a bubble or eddy of the proper dimension may be employed.

In some instances where the roof of the cab of the vehicle is occupied by a box-like structure such as an air conditioner or the like for example, this structure will not in itself provide any separation of flow sufficient to provide material drag reduction. However, under these conditions the provision of a vane 105 forwardly of and extending slightly above the rounded corner of the box 106 as shown in FIG. 22 will cause a widely deflected air stream 107, as illustrated by the arrows, and produce a sufficient deflection to cause the air stream to readhere to the sides of the trailer creating a bubble or eddy in the space between the trailer and the tractor as previously described.

Obviously many other expedients may be employed to achieve the principle of the instant invention, although there are herein disclosed certain preferred embodiments thereof.

From the foregoing it will now be seen that there is herein provided an improved shield or deflector for attachment to the tractor of a tractor-trailer combination, or which may be integrally manufactured therewith, which produces a material reduction in the drag of the combination, and consequent saving in time, expense and driver effort, whereby the effective capacity of the vehicle is no way reduced and which minimizes the effects of yaw or cross wind on the vehicle, which accomplishes all of the objects of this invention, and others, including many advantages of great practical utility and commercial importance.

As many embodiments may be made of this inventive concept, and as many modifications may be made in the embodiment hereinbefore shown and described, it is to be understood that all matter herein is to be interpreted merely as as illustrative, and not in a limiting sense.

I claim:

1. In combination with a tractor-trailer vehicle having a gap between the tractor and the trailer, said tractor being of less height than said trailer, an airflow deflecting baffle mounted to extend above the cab roof of said tractor for diverting the air flow relatively widely in a manner to avoid entry of the air stream into said gap thereby creating at least one low pressure air eddy in said gap to reduce the frontal air pressure against the trailer, said diverted air reattaching to the trailer at points spaced rearwardly of said gap, said baffle being inclined vertically rearwardly and forwardly convexed in a horizontal plane, positioned a distance from the front of the trailer equal to approximately 0.7 the half width of the trailer end of a height substantially 0.7 of the difference in height between the tractor cab roof and the roof of the trailer.

2. In combination with a tractor-trailer vehicle having a gap between the tractor and the trailer, an air flow deflecting shield comprising a baffle mounted to extend above the tractor cab roof, said baffle being vertically inclined rearwardly and forwardly convexed in a horizontal plane, said baffle having a predetermined height substantially 0.7 of the difference in height between said cab roof and the trailer roof, said baffle being positioned a distance from the front of the trailer equal to approximately 0.7 the half width of the trailer.

3. In combination with a tractor-trailer vehicle having a gap between the tractor and the trailer, said tractor having a cab with the roof thereof of less height than said trailer, a substantially solid upstanding air flow deflecting baffle mounted to extend above the cab roof and having its lower edge in substantially air impervious relation therewith, for diverting the substantially entire air flow relatively widely in a manner to avoid entry of the air stream into the gap, thereby creating at least one low pressure air eddy in said gap to reduce the frontal air pressure against the trailer, the diverted air reattaching to the trailer at points spaced rearwardly of said gap, said baffle being of a height between 0.5 and 0.9 of the difference in height between the tractor cab roof and the roof of the trailer, and being positioned a distance from the front of the trailer equal to between 0.3 and 2.0 times the half width of the trailer.

4. The structure of claim 3 wherein said baffle is positioned immediately adjacent the rear of the cab roof.

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MILTON BUCHLER, *Examiner.*

APPENDIX K

PAGE

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A 100

Dec. 9, 1958 A. F. STAMM 2,863,695

TRACTOR-TRAILER AIRSTREAM CONTROL KIT

Filed Nov. 19, 1954 2 Sheets-Sheet 1

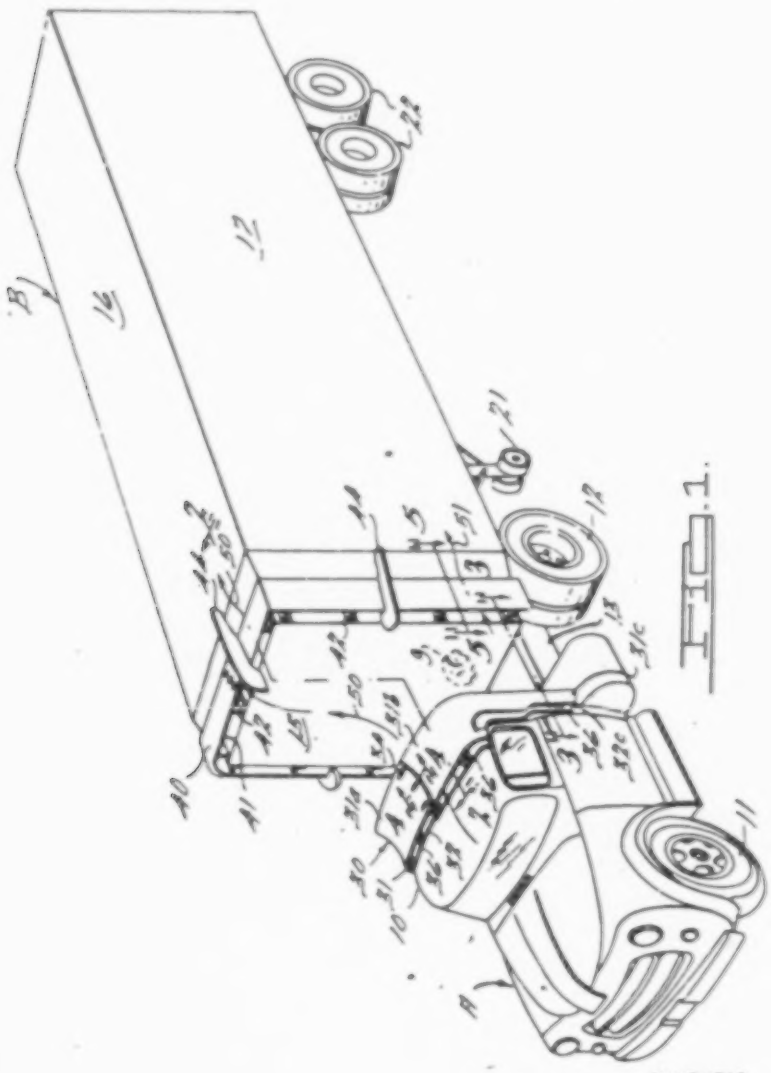

FIG. 1.

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TRACTOR-TRAILER AIRSTREAM CONTROL KIT

Filed Nov. 19, 1954 2 Sheets-Sheet 2

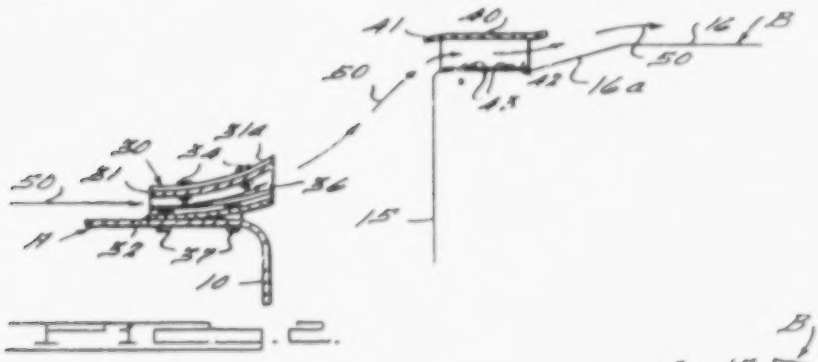

FIG. 2.

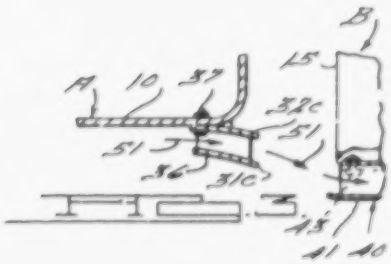

FIG. 3.

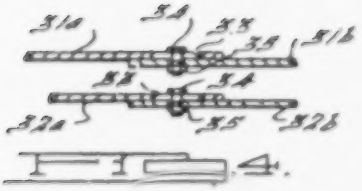

FIG. 4.

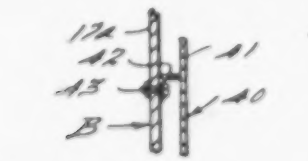

FIG. 6.

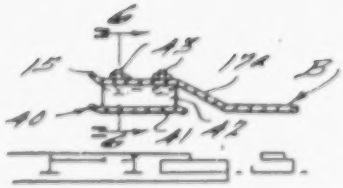

FIG. 5.

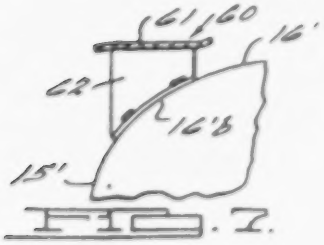

FIG. 7.

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United States Patent Office 2,863,695 Patented Dec. 9, 1958

2,863,695

TRACTOR-TRAILER AIRSTREAM CONTROL KIT

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Application November 19, 1954, Serial No. 469,913

2 Claims. (Cl. 296—1)

As a result of a series of comprehensive wind tunnel tests recently conducted on scale models of present day tractor-trailer combinations, and various modifications thereof, a number of revealing conclusions as to tractor-trailer air flow drag losses and their relation to tractor-trailer design have become obvious.

The more important conclusions resulting from the aforementioned tests are:

(1) A significant reduction in horsepower drag losses in tractor-trailer combinations can be achieved by controlling the air flow between the rear of the tractor cab and the front end of the attached trailer body.

(2) Rounding or beveling the top and side edges of the front end of the trailer body produces a significant reduction in tractor-trailer drag losses.

(3) Tractor-trailer drag losses seem to increase with increase in the space between the tractor cab and the front end of the trailer body, at least up to a certain limit.

(4) The use of skirting beneath the tractor front end and along the lower portions of the trailer body sides also reduces tractor trailer drag losses.

(5) Rounding or beveling of the side and top edges of the rear wall of the trailer body has little effect on reducing tractor-trailer drag losses.

(6) The use of streamlining at the rear end of the trailer body, such as by use of a tapering tail section on the trailer body, does not reduce drag losses sufficiently to justify the accompanying reduction in trailer load carrying capacity.

(7) The use of deflecting vanes at the rear end of the trailer body does not produce any significant reduction in tractor-trailer drag losses.

(8) Removal of the tractor under-body-mounted spare tire and its carrier gear, the tractor gas tanks, and projecting frame cross members on the undercarriage of the trailer, does not produce any significant reductions in tractor-trailer drag losses.

The aforementioned wind tunnel tests very definitely established that when streamlining was applied to the region between the rear of the tractor cab and the front end of the trailer body, so as to control the air flow rearwardly from the cab and prevent turbulence in this region, that then a significant reduction in drag losses should result. While it would be most efficient to have a smooth surfaced sheeting extend rearwardly from the periphery of the tractor cab to the peripheral edges of the front wall of the trailer body, so as to completely enclose the space between the tractor cab and the attached trailer body, still, such an arrangement would not be feasible due to the fact that the tractor cab and the trailer body must be free to rotate relative to each other through approximately 180 degrees. Accordingly, it is a primary object of this invention to provide a practical device that may be readily applied to any conventional tractor-trailer combination to control the air flow between the tractor cab and the front end of the trailer so as to significantly reduce the drag losses that normally result from the air flow turbulence in this region.

It is another object of this invention to provide an accessory kit that may be readily applied to the rear portion of a conventional tractor cab and to the front end of the tractor attached trailer body so as to control air flow between the tractor cab and attached trailer body.

It is still another object of this invention to provide an air flow control attachment for the rear portions of tractor cabs that is adapted to guide the air flow rearwardly towards and across the rearwardly located tractor attached trailer body and thereby reduce the drag losses of such a combination of attached vehicles.

It is still another object of this invention to provide an air flow control attachment for the edge portions of the front wall of a tractor drawn trailer body that is adapted to reduce the turbulence that normally exists at the front end of the trailer that is drawn by a conventional tractor.

Other objects and advantages of this invention will become readily apparent from a reading of the following description and a consideration of the related drawings wherein:

Fig. 1 is a perspective view of a tractor drawn trailer equipped with the air flow control device embodying this invention;

Fig. 2 is an enlarged, fragmentary, sectional elevational view taken along the line 2—2 of Fig. 1;

Fig. 3 is an enlarged, fragmentary, sectional elevational view taken along the line 3—3 of Fig. 1;

Fig. 4 is an enlarged, fragmentary, sectional elevational view taken along the line 4—4 of Fig. 1;

Fig. 5 is an enlarged, fragmentary, sectional elevational view taken along the line 5—5 of Fig. 1;

Fig. 6 is an enlarged, fragmentary, sectional elevational view taken along the line 6—6 of Fig. 5; and

Fig. 7 is a fragmentary sectional elevational view of a modified form of front end construction for the trailer body.

In the drawings A represents the motor driven towing tractor vehicle and B represents the towed trailer vehicle that is attached to the tractor A by conventional king pin bearing means 9 that are shown schematically. The tractor A has cab 10 that is of conventional size, location and shape. The tractor cab 10 is usually only about one-half as high as the top of the body of the trailer B and is spaced forwardly of the front wall of the rearwardly positioned trailer B. Wheels 11 and 12 support the chassis frame 13 of the tractor A.

The body of trailer B is essentially an elongated box that includes a front wall 15, a top wall 16, and opposed side walls 17. Trailer B includes conventional landing gear 21 and rear wheels 22.

As has been previously pointed out, considerable drag loss can be eliminated by reducing the air flow turbulence that normally occurs between the rear of the tractor cab 10 and the front end of the towed trailer B. This invention discloses a simplified, readily applied, accessory kit that can be installed on the tractor cab and on the adjacent front end portion of the tractor towed trailer body to materially reduce the drag losses of such a combination of vehicles. It is the prime purpose of this accessory kit to provide a means for readily controlling the air flow from the cab rearwardly across the space between the back end of the tractor cab 10 and the front end 15 of the rearwardly located trailer B. By controlling the air flow across the space between the tractor cab and the trailer body it is possible to direct the manner of air flow across the surfaces of the trailer and thereby keep turbulence to a minimum.

The air flow accessory kit embodying this invention comprises a cab mounted portion 30 and a trailer mounted portion 40. The cab mounted portion 30, see Figs. 1 and 2 particularly, includes a pair of spaced apart shells

31 and 32 that are of a substantially inverted U-shaped cross sectional configuration. The bight portions of the U-shaped shells 31, 32 are adapted to extend across and be suported on the roof of the tractor cab 10 whereas the leg portions of the U-shaped shells 31 and 32 are adapted to extend downwardly along and to be connected to the side walls of the tractor cab 10 adjacent the rear end of the cab 10. Each of the U-shaped shells or shrouds 31 and 32 may be made in two sections which sections are each of substantially L-shaped cross-sectional configuration. The base leg portions 31*a*, 32*a* and 31*b*, 32*b* (see Fig. 4), that overlie the roof of the tractor cab 10 are arranged in overlapping relationship and each of the legs 31*a* and 32*a* has one or more slots 33 that are adapted to receive the bolts 34. Bolts 34 threadably receive the nuts 35 so that the shells or shrouds 31 and 32 may be adjusted in width to fit tractor cabs of different sizes. The shell or shroud elements 31 and 32 have their leg portions 31*c* and 32*c* respectively mounted on and extending downwardly adjacent to the sides of the cab 10 at the rear end portion thereof (see Figs. 1 and 3). Stiffener plates 36 extend between the spaced apart shells or shrouds 31 and 32 to maintain these elements in spaced apart relationship. Bolt type connectors, such as the elements 37, may be used to fixedly mount the shell elements 31 and 32 on the tractor cab 10. Obviously any equivalent screw, clamp or tack welding means could be substituted for the bolt connectors 37 herein disclosed.

It will be noted from Figs. 2 and 3 that the spaced apart shells 31 and 32 are shaped so as to diverge towards the rear of the cab 10. Also, the portions of the shells 31, 32, that overlie the top of the tractor cab 10, are tilted upwardly in addition to diverging so that the airstream flowing rearwardly through the conduit means formed by the spaced shell portions 31*a*, 31*b* and 32*a*, 32*b* will be discharged upwardly towards the upper edge of the front wall 15 of the trailer body. The arrows 50, see Fig. 2, show the airstream control effect that results from passing the airstream discharged from the rear of the tractor cab roof through the spaced shell conduit means 31, 32. It will be noted that the airstream discharged from the shells 31, 32 is directed, as shown by arrows 50, upwardly and rearwardly so that it will pass into the conduit 40 that is located around the periphery of the front wall 15 of the body of the trailer B. This controlled air flow from the rear portion of the tractor cab 10 prevents or substantially eliminates, the air flow turbulence that otherwise results at the front end of the trailer body and as a result drag losses are materially reduced.

The same type of controlled airstream flow occurs along the sides of the tractor cab 10 as occurs across the top of the tractor cab. From Fig. 3 it will be noted that the leg portions 31*c*, 32*c* of the spaced apart shell elements 31, 32 provide a conduit means for collecting and controlling the discharge of the airstream from along the sides of the tractor cab 10. The leg 32*c* of shell 32 is fixed to the cab body 10 by the bolt connectors 37 and spacer plates 36 space the shell legs 31*c*, 32*c*. The shell legs 31*c*, 32*c* diverge rearwardly and are also tilted outwardly from the body of the tractor cab 10 to cause the airstream flow, as indicated by the arrows 51, to pass outwardly from the tractor cab 10 towards the conduit 40 that extends around the front wall 15 of the trailer body. This controlled airstream flow along the sides of the truck cab and the trailer prevents turbulence at the front end of the trailer and reduces drag losses.

The conduit 40 that is fixed to the front end of the trailer body comprises a shell or shroud 41 element of substantially inverted U-shaped cross sectional configuration. This shell element 41 may be composed of two substantially L-shaped sections that are bolted together by bolt and slot connector means similar to the aforedescribed means 33—35. The making of the shroud 41 in adjustably connected sections permits it to be fitted to varying size trailers. The conduit 40 is designed to fit about the edges of the front end of the trailer body in spaced relation thereto so as to provide an airstream conduit to control the discharge of the airstream along the outer surfaces of the trailer body. Shell 41 is held in outwardly spaced relation to the front end of the trailer body by the spacer plates 42. The spacer plates 42 may be fixedly connected to the trailer body and nut connectors 43 or by any equivalent type of connection.

From Figs. 2 and 5 it will be noted that the front end of the trailer is preferably formed with a recessed step-like formation 16*a*, 17*a* that is intended to receive the conduit shell 40. By providing a recess to receive the conduit member 40, the trailer roof can be extended upwardly to the prescribed overhead limits and thus valuable trailer load carrying capacity is not sacrificed. Obviously the conduit member 40 could be mounted on top of a perfectly flat trailer roof if the overhead projection of the conduit member 40 did not present economic or regulatory problems. As indicated by the arrows 50 and 51 in Figs. 2 and 3, the cab conduit or shell member 30 will cause airstream flow along the top and sides of the cab to be directed rearwardly in such a fashion that it will be directed into the trailer mounted conduit shell member 40 and thereafter discharged along the top and sides of the trailer body in a fashion that tends to reduce airstream turbulence and thereby reduce drag losses. The trailer mounted conduit member 40 may also include a number of guide vanes 44 that project into the airstream and assist in controlling its path of flow.

Fig. 7 shows a modified form of trailer mounted, shell-type, airstream gathering and discharge conduit 60. The conduit 60 is adapted to be mounted on the front end of a trailer body 16' that has the edges of its front wall rounded or curved rather than formed with recessed step formations such as 16*a*, 17*a* of the form of the invention shown in Figs. 1–6. The shell member 61 of the Fig. 7 form of the invention is substantially identical to the member 41 shown in Figs. 1–6. However, the spacer support plates 62 for the shell plate 61 in the Fig. 7 form are formed to fit the curvature of the trailer body at its front end. These spacer plates 62 could be made as shown or as adjustable devices to fit different types of body curvatures. In all other respects the shell type conduit 60 of Fig. 7 is similar in structure and function to the shell conduit 40 of the Fig. 1–6 form of this invention.

While this invention shows the airstream control kit for the tractor-trailer combination made in the form of an accessory item that can be added to existing tractors and/or trailers, still, it is within the scope of this invention to form the tractor and/or trailer airflow conduit elements as integral parts of the tractor cab and trailer body if so desired. It is also possible, and within the scope of this invention, to use merely one or the other of the two airflow control conduits under certain circumstances. Also it is a part of this invention to include in combination with the trailer mounted airflow conduit elements, the step-like (Fig. 1) or rounded (Fig. 7) peripheral edge portions of the front wall of the trailer body for these trailer body formations materially assist in controlling the flow through the trailer mounted conduit and thereby reducing turbulence and attendant drag losses.

I claim:

1. In a tractor-trailer combination vehicle having the tractor cab spaced forwardly of the trailer body, a first open-ended, conduit type, airflow control means mounted on the rearwardly located top and side peripheral surface portions of the tractor cab to receive and guidingly discharge the airstream passing rearwardly over the tractor body during forward motion thereof, said first airflow control means being arranged to discharge the

said airstream towards top and side peripheral portions of the front end of the rearwardly positioned trailer, said top and side peripheral portions of the trailer front end being depressed to provide airflow guiding formations, and a second open-ended, conduit, type, airflow control means mounted on the depressed peripheral surface portions of the front end of the trailer to receive the airstream discharged by the tractor mounted airflow control means and to guidingly discharge said airstream rearwardly along the peripheral surface portions of the trailer, said airflow means each comprising an inverted U-shaped frame member composed of a plurality of adjustably interconnected frame elements.

2. In a tractor-trailer combination vehicle having the tractor cab spaced forwardly of the trailer body, a first open-ended, conduit type, airflow control means mounted on the rearwardly located top and side peripheral surface portions of the tractor cab to receive and guidingly discharge the airstream passing rearwardly over the tractor body during forward motion thereof, said first airflow control means being arranged to discharge the said airstream towards the top and side peripheral portions of the front end of the rearwardly positioned trailer,

the top and side peripheral portions of the front end of said trailer having a depressed step formation therein, and a second open-ended, conduit type, airflow control means mounted in the depressed step formation formed around the peripheral surface portions of the front end of the trailer to receive the airstream discharged by the tractor mounted airflow control means and to guidingly discharge said airstream rearwardly along the peripheral surface portions of the trailer.

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APPENDIX L

PAGE

Austrian Patent 62,329 to Constantin

Original Text A105-A107

Translation A108-A112

Klasse 63 c. A 105 Ausgegeben am 25. November 1918.

KAIS. KÖNIGL. PATENTAMT.

Österreichische

PATENTSCHRIFT Nr. 62329.

LOUIS CONSTANTIN IN PARIS.

Einrichtung an Fahrzeugen zur Verminderung des Bewegungswiderstandes.

Angemeldet am 18. März 1913; Priorität vom 18. März 1911 (Anmeldung in Spanien).

Beginn der Patentdauer: 1. Juli 1913.

Es ist bekannt, den Widerstand des Mediums bei Bewegung von Fahrzeugen im Wasser oder in der Luft dadurch herabzusetzen, daß man dem Vorderteil des Fahrzeuges eine zugespitzte Form gibt.

Diese Anordnung, wie sie sowohl bei Schiffen als auch bei Landfahrzeugen und Luftschiffen verwendet wird, sieht zwischen dem vorderen Grate oder dem äußersten Teile des Fahrzeuges, der in das Medium eindringt, und dem Körper des Fahrzeuges eine durch schräge Wände oder gerichtete Flächen gebildete Verbindung vor, welche mit dem Fahrzeugkörper aus einem Stück besteht. Der auf diese Weise entstehende Bug ist notwendigerweise wenig oder schlecht verwertbar und belastet das Fahrzeug mit einer Vermehrung des toten Gewichtes, die keineswegs durch eine Erhöhung des relativen Fassungsvermögens ausgeglichen wird.

Übrigens kann eine Verbesserung eines vorhandenen Fahrzeuges unter diesen Umständen nicht anders erfolgen, als durch die vollständige Umgestaltung des Vorderteiles, die nicht immer möglich ist: Als Beispiel sei ein Automobil mit geschlossener Karosserie, etwa eine Limousine, angeführt, bei welcher man nicht darum denken kann, den Ausblick vollständig zu verdecken, indem man an die Karosserie einen zugespitzten Bug anfügt, der mit ihr einen gemeinsamen Körper bildet.

Die vorliegende Erfindung hat nun in erster Linie den Zweck, die Konstruktion von Fahrzeugen zu ermöglichen, die sehr kompendiös sind, d. h. ein großes relatives Fassungsvermögen zeigen und dank eines besonders gestalteten Ansatzes von geringem Gewicht und kleinem Volumen gleichzeitig dadurch ausgezeichnet sind, daß der Bewegungswiderstand des betreffenden Mediums ein unbedeutender wird. In zweiter Linie bezweckt die Erfindung die Verbesserung vorhandener Fahrzeuge in dem gleichen Sinne, und zwar ohne wesentliche Vermehrung des Gewichtes und ohne zu eingreifende Umgestaltung des Fahrzeuges.

Die Erfindung stützt sich auf die Tatsache, daß die dünnen Schichten des Mediums, die durch einen in Bewegung befindlichen Körper seitlich verschoben werden, auf eine bestimmte Strecke hin fortgesetzt abgelenkt bleiben, auch nachdem sie außer Berührung mit dem genannten Körper gekommen sind, und daß sie in dieser Ablenkung die Schichten des Mediums, denen sie begegnen, mit sich reißen.

Wenn man also in einer entsprechenden Entfernung vor dem Fahrzeug einen Schirm von passend gestaltetem Querschnitt anbringt, der kleiner ist als der des Wagenvorderteiles, so werden die Schichten des Mediums, die durch diesen Schirm abgelenkt werden, auch andere Schichten aus der Bahn des Wagens herausschaffen, welche ohne den Schirm das Fahrzeug getroffen und der Bewegung einen Widerstand entgegengesetzt hätten. Es zeigt sich also, daß das Fahrzeug in diesem Falle nicht den Widerstand einer Säule des Mediums zu überwinden haben wird, die denselben Durchmesser besitzt wie sein Vorderteil, sondern nur jenen einer Säule von dem Durchmesser des Schirmes. Demnach wird eine Verminderung des Widerstandes eintreten. Des weiteren ergibt sich, daß diese Verminderung um so erheblicher sein wird, um so kleiner der Widerstand beim Vorwärtsgange des Schirmes selbst ist, selbstverständlich insoweit das Vermögen der seitlichen Ablenkung dieses letzteren dadurch nicht vermindert erscheint.

Dieses Ergebnis wird der Erfindung gemäß erzielt, indem man die Wände des Schirmes aus Flächen bestehen läßt, die sich in einem Winkel schneiden, wobei die durch die Schnittlinie (den Grat) gelegte Symmetrieebene je nach Erfordernis horizontal oder vertikal stehen kann, die Flächen des Schirmes können ferner auch den Mantel eines Kegels bilden.

Eine sehr starke seitliche Ablenkungskraft läßt sich dadurch erzielen, daß man den Schirm nicht in Form einer einzigen kontinuierlichen Fläche ausbildet, sondern aus einer Anzahl von übereinander gelegten Lamellen herstellt, wobei diese Blätter zweckmäßig gekrümmten Querschnitt besitzen, um Stoß- und zu plötzliche Ablenkungen, die immer Energieverluste bedeuten, zu vermeiden.

Die Zeichnungen stellen in schematischer Darstellung einige beispielsweise gewählte Ausführungsformen der Erfindung dar. Fig. 1 zeigt einen schalenartigen Schirm an der Vorderseite eines Fahrzeuges, Fig. 2 einen mit einem konischen Schirm ausgerüsteten Vorderteil, die Fig. 3 und 4 zeigen in Seiten- und Vorderansicht parallel zueinander angeordnete Lamellen, wie sie zur Herstellung eines aus mehreren Blättern bestehenden Schirmes verwendet werden. Fig. 5 veranschaulicht in kleinerem Maßstabe den Vorderteil eines Fahrzeuges, der mit einem aus parallelen Lamellen gebildeten Schirm versehen ist, wobei diese Lamellen zu beiden Seiten einer Mittelrippe oder eines Grates angeordnet sind. Fig. 6 zeigt einen mehrteiligen konischen Bug in Vertikalschnitt.

Auf diesen Figuren stellen dar: *a* den Vorderteil eines beliebigen Fahrzeuges für die Fortbewegung zu Land, zu Wasser oder in der Luft, *b* den Schirm oder Bug und *c* einen Träger, der den Schirm mit dem Fahrzeug verbindet.

In den Fig. 3, 4, 5 und 6 sind die Lamellen, aus denen der Bug gebildet wird, mit b, b^1, b^2 bezeichnet. Die einzelnen Lamellen sind durch Zwischenstücke *d* (Fig. 5 und 6) miteinander verbunden.

Mit einem Schirm, der aus einer einzigen Serie von parallelen Lamellen besteht, wie sie in den Fig. 3 und 4 gezeigt sind, kann das Medium nur nach einer Richtung abgelenkt werden, die verändert werden kann, indem man die Stellung des Schirmes wechselt. Der Bug nach Fig. 5 ist zur Ablenkung des Mediums entweder nach den zwei Längsseiten des Fahrzeuges oder oberhalb und unterhalb desselben bestimmt, je nach der Lage, die man dem Schirm im Verhältnis zum Fahrzeuge gibt.

Ein konischer bzw. aus den Mantelflächen eines Kegelstutzes zusammengesetzter Schirm, wie in Fig. 6 veranschaulicht, bietet die Möglichkeit, das Medium um das ganze Fahrzeug herum abzulenken.

Die Form und die Anordnung der Platten kann in mannigfaltiger Weise abgeändert werden, ohne aus dem Rahmen der Erfindung herauszutreten.

PATENT-ANSPRÜCHE:

1. Einrichtung an Fahrzeugen zur Verminderung des Widerstandes des Mediums, dadurch gekennzeichnet, daß in einer entsprechenden Entfernung vor dem Fahrzeug ein Schirm von kleinerem Querschnitt als der des Fahrzeugvorderteiles mit geneigten, in einer Kante sich schneidenden oder den Mantel eines Kegels bildenden Flächen angebracht ist, derart, daß, wenn sich das Fahrzeug mit seiner normalen Geschwindigkeit fortbewegt, die Flächen des Bugs das begegnende Medium (Luft oder Wasser) so ablenken, daß dieses auf keinen Teil des Fahrzeugkörpers auftrifft.

2. Ausführungsform der Einrichtung nach Anspruch 1, dadurch gekennzeichnet, daß die geneigten Flächen des Bugs durch eine Anzahl von Lamellen gebildet werden, zwischen welchen für das Medium Durchgänge oder Kanäle ausgespart sind.

3. Ausführungsform der Einrichtung nach Anspruch 2, dadurch gekennzeichnet, daß die Lamellen gekrümmt sind.

Zur Patentschrift
Nr 62320.

Fig.1.

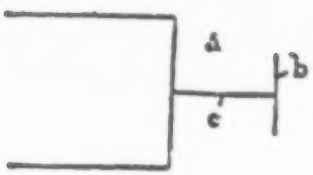


Fig.2.

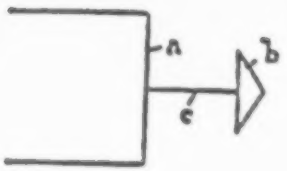
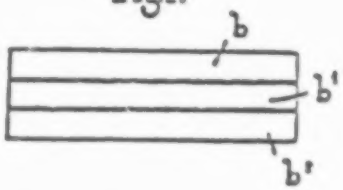


Fig.3

Fig.4.



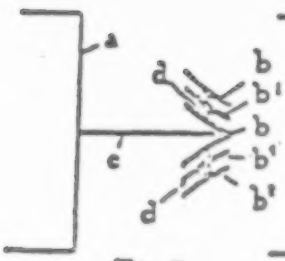


Fig.5.

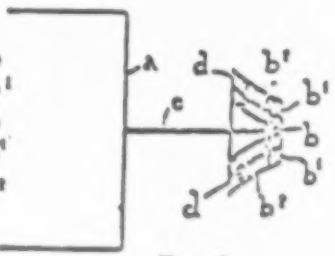


Fig.6.

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Class 63c

Issued on November 25, 1913

IMPERIAL-ROYAL PATENT OFFICE

Austrian Patent 62,329

LOUIS CONSTANTIN of PARIS

DEVICE ON VEHICLES FOR REDUCING THE RESISTANCE TO MOTION

Filed on March 18, 1912; Priority of March 18, 1911
(Application in Spain)

Start of the Patent Life: July 1, 1913

CERTIFICATE OF ACCURACY

STATE OF NEW YORK)
COUNTY OF NEW YORK) ss:

This is to certify that on this day personally appeared before me, a Notary Public in and for the aforesaid State and County, Arthur Tannenbaum who, after being duly sworn, deposes and says:

"That he is a translator of the German and English languages;

That he is associated with TANNENBAUM TRANSLATION SERVICE;

That he is thoroughly conversant with these languages;

That he has carefully compared the attached English translation of the annexed document written in the German language;

That the said translation is a correct and true translation of such document and of the whole thereof"

/s/ ARTHUR TANNENBAUM
Translator

Sworn and subscribed to before me this 11th day of August 1982

/s/ NINA CHANEVICH
Notary Public

NINA CHANEVICH
NOTARY PUBLIC, State of New York
No. 41-4735528
Qualified in Queens County
Commission Expires March 30, 1983

[SEAL]

It is known to reduce the resistance of the medium during the movement of vehicles in water or in the air by endowing the front part of the vehicle with a tapered shape.

This arrangement, as it is used with ships, as well as with land vehicles and airships, provides between the front spine or the outermost part of the vehicle penetrating into the medium and the body of the vehicle a connection formed by sloped walls or inclined surfaces, which is integral with the body of the vehicle. The bow formed in this way is necessarily of little use or is poorly usable and burdens the vehicle with an increase in its deadweight that is in no way compensated for by an increase in its relative carrying capacity.

Furthermore, an improvement of an existing vehicle can, under these conditions, not be achieved otherwise than by the complete rebuilding of its front part, which is not always possible: as an example, we may cite an automobile with a closed body, such as a limousine, with regard to which one would not think of completely blocking the view by attaching to the body a tapered bow, forming with it an integral member.

The object of the present invention is, firstly, to make possible the building of vehicles that are very compact, that is, that have a large relative carrying carrying capacity and that, as a result of a specially shaped attachment of low weight and small volume, are at the same time characterized in that the resistance to motion of the medium in question becomes insignificant. Secondarily, the invention aims at the improving of existing vehicles in the same sense, i.e., without a significant increase in weight and without any major rebuilding of the vehicle.

The invention is based on the fact that the thin layers of the medium that are laterally displaced by a body in motion continue to remain deflected over a certain distance, even after they are no longer in contact with the said body, and that, in this deflection, they carry along the medium layers they encounter.

Therefore, if one attaches at a suitable distance ahead of the vehicle a shield of suitably shaped cross-section that is smaller than that of the front of the car, the layers of the medium that are reflected by this screen will remove out of the path of the car also other layers that, without the shield, would have struck the

vehicle and provided a resistance to the motion. It can thus be seen that the vehicle will in this case not have to overcome the resistance of a column of the medium that has the same diameter as its front part, but only that of a column of the diameter of the shield. Accordingly, there will occur a reduction of the resistance. It follows furthermore that this reduction will be that much more substantial the smaller the resistance upon the forward motion of the shield itself, of course, insofar as the capacity of lateral deflection of the latter does not appear to be reduced thereby.

This result is achieved, according to the invention, in that the walls of the shield are allowed to consist of surfaces intersecting at an angle, in which the plane of symmetry passing through the line of (the spine) can be horizontal or vertical, as required; the surfaces of the shield can also form the generated surface of a cone.

A very strong lateral deflecting force can be achieved in that the shield is designed not in the form of a single continuous surface but is made of a plurality of superposed sheets, with these sheets suitably having a curved cross-section, in order to prevent impacts and excessively abrupt deflections which always result in energy losses.

The drawings show schematically some embodiments of the invention, selected as examples.

Fig. 1 shows a disc-like shield on the front side of a vehicle;

Fig. 2 shows a front part outfitted with a conical shield;

Figs. 3 and 4 show as side and front view, sheets arranged parallel to one another, such as are used for the manufacture of a shield consisting of a plurality of sheets.

Fig. 5 illustrates, on a smaller scale, a vehicle front part equipped with a shield formed out of parallel sheets, with these sheets being arranged on both sides of a center rib or a spine.

Fig. 6 shows a multipart conical bow as a vertical section.

On these figures there represent: *a* the front part of any vehicle for the forward movement on land, water, or in the air; *b* the shield or bow, and *c* a support connecting the shield with the vehicle.

In Figs. 3, 4, 5, and 6, the sheets constituting the bow are designated by b, b^1, b^2. The various sheets are interconnected via spacers *d* (Figs. 5 and 6).

In a shield consisting of a single series of parallel sheets, as they are shown in Figs. 3 and 4, the medium can be deflected into one direction only, which can be modified by changing the position of the shield. The bow according to Fig. 5 is intended for the deflection of the medium either toward the two longitudinal sides of the vehicle or above and beneath same, depending on the position imparted to the shield with respect to the vehicle.

A conical shield or a shield assembled out of the generated surfaces of a truncated cone, as illustrated in Fig. 6, affords the possibility of deflecting the medium around the entire vehicle.

The shape and the arrangement of the plates can be modified in a variety of ways without departing from the scope of the invention.

CLAIMS

1. Device on vehicles for reducing the resistance of the medium, characterized in that at a coresponding distance ahead of the vehicle there is mounted a screen of a smaller cross-section than that of the front part of the vehicle, with sloped surfaces intersecting in an edge of forming the generated surface of a cone so that, when the vehicle moves forward at its normal speed, the surfaces of the bow deflect the medium (air or water) being encountered in such a way that same does not strike any part of the vehicle body.

2. Mode of realization of the device according to Claim 1, characterized in that the sloped surfaces of the bow are constituted by a plurality of sheets between which there have been recessed passages or ducts for the medium.

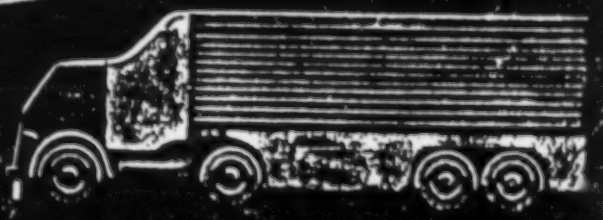
3. Mode of realization of the device according to Claim 2, characterized in that the sheets are curved.

APPENDIX M

PAGE

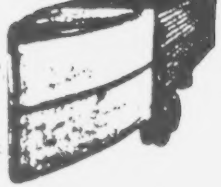
Booklet Published by Trailmobile Inc. A113-A128

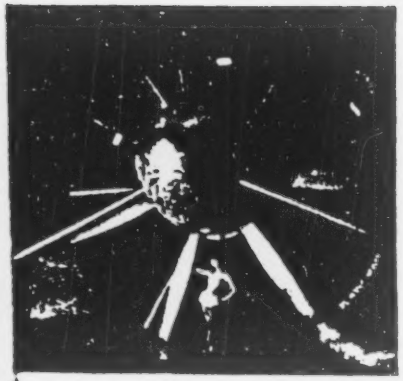
wind resistance

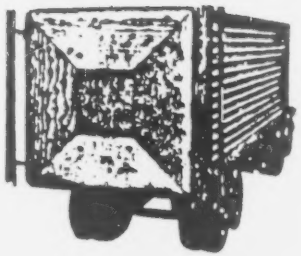


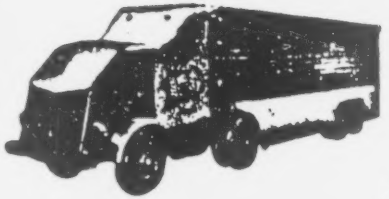
A research-study from the subsonic wind tunnel at the University of Maryland — showing data on the cause and effect of aerodynamic design on commercial trailers

A 113









In this booklet...

Page 3... *The Point of Diminishing Return* by Professor A. Wiley Sherwood.

Pages 4 and 5.... What is a Wind Tunnel and how does it work?

Page 6... Preparations for Wind Tunnel tests to show effect of wind resistance on truck-trailers.

Page 7... What is Wind? How does it affect trucking operations?

Pages 8 and 9.... Various combinations of truck-trailer designs and their effect on wind resistance.

Page 10.. How trailer front corner radius designs effect changes in wind resistance and horsepower requirements.

Page 11.. How wind resistance varies when both the trailer's front *roof and corner* radius is changed.

Page 12.. What part do the sides of trailers play in decreasing or increasing wind resistance?

Page 13.. Average fuel savings when the trailer front and side are tested in various combinations.

Pages 14 and 15... Aerodynamic tests to discover how design changes effect wind resistance.

Page 16.. An important conclusion; the future outlook for equipment streamlining in relation to cubic capacity.

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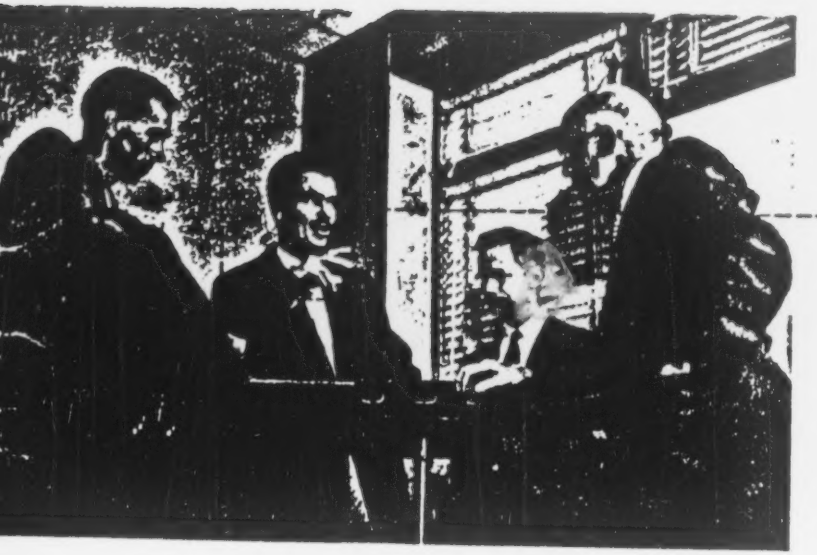
"The point of diminishing return . . ."



A. Wiley Sherwood,
Professor of Aerodynamics,
Manager of Wind Tunnel Research
University of Maryland
College Park, Maryland

"**There is a point of diminishing return** in the design of aircraft and in truck-trailers. In aircraft, the point is reached when streamlining sharpens to the degree where there is no longer sufficient room for pilots and fighting gear.

"*In truck-trailers, the point of diminishing returns takes place when exterior streamlining eats into interior cargo space.*

"*Where is that point?*"

"The following pages define this elusive point, and for the first time show the results of Wind Tunnel tests on various areas of truck-trailers."

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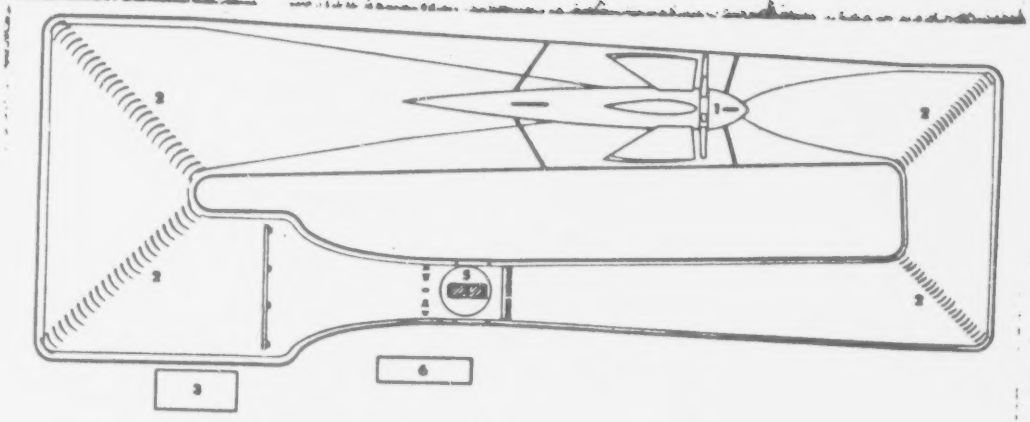
What is a *WIND TUNNEL* and how does it work?

Up to this time, wind tunnels have been used almost exclusively to test advanced aeronautical designs. The wind tunnel can simulate actual flight conditions which affect airplanes, and air flow over various surfaces. Likewise, the wind tunnel can tell trailer manufacturers how their products react to wind drag. Engineers and designers must know how their finished product will perform—how much drag, lift and yaw will result from a design change in a wing, nose, front, tail or side assembly, or in the case of trailers, the fronts, roofs, sides, rear end assemblies and undercarriages of trailers.

Important parts of the University of Maryland Wind Tunnel, numbered below, correspond with those in the scale drawing at right:

1. 2250 horsepower fan creates winds up to 150 miles per hour.
2. Giant water-cooled deflecting vanes guide wind around corners of tunnel and reduce turbulence so that wind flow over trailer is smooth.
3. Power supply station for operation of 2250 H.P. electric motor to generate 150 m.p.h. air current.
4. Working section of wind tunnel. Note that this area is compressed into a "bottle neck." Here is where the wind reaches its highest velocity and where the model truck-trailers to be tested are placed.
5. Turntable operates in a complete 360° circle so that the wind can strike the trailer model being tested from every possible angle. Wind drag readings are taken by electronic computing devices at every angle—full front, three-quarter front, full side, three-quarter rear, full rear to check variation in drag.
6. Wind tunnel control room where operator-engineers control speed of wind and the angle of the trailer model being tested.



The University of Maryland Wind Tunnel is 166 feet in length and 60 feet in width.

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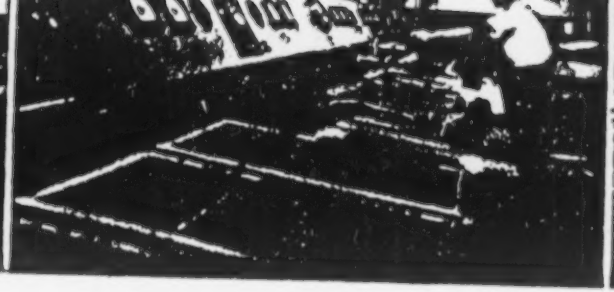
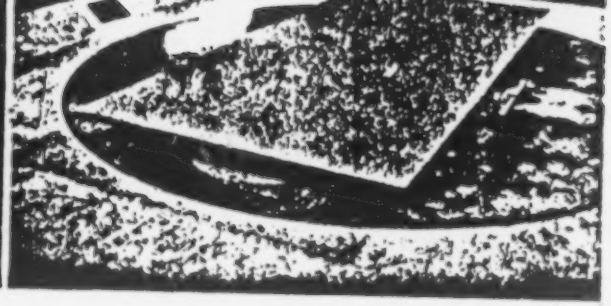
Wind Tunnel Control Room as viewed from the wind tunnel. Note exact scale model wood parts on table awaiting assembly.



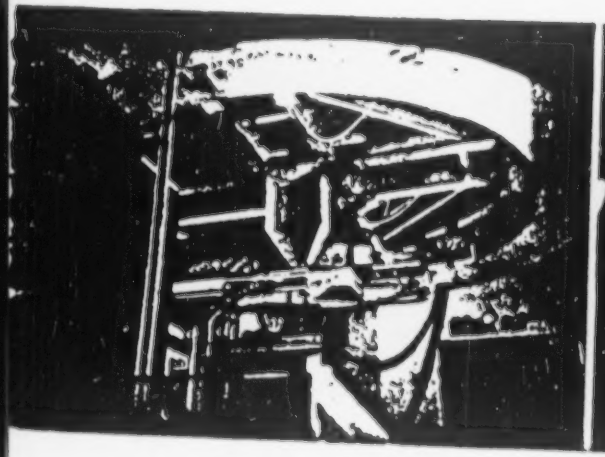
Console Board in control room. From here the engineer can control the wind speed and the angle of the model into the wind.



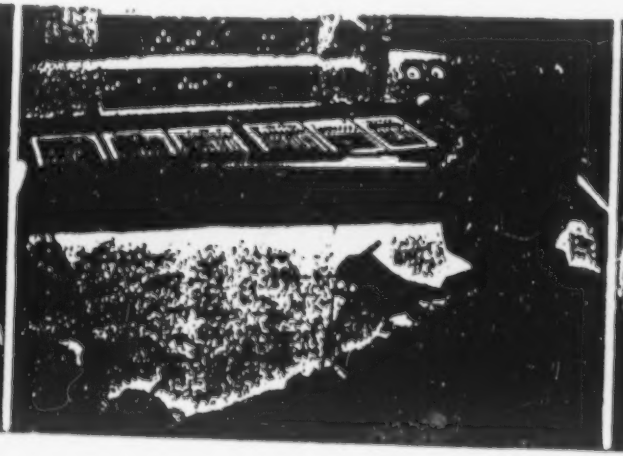
Ground Board and Balance Turntable in working section of wind tunnel. As wind strikes model the "drag" is transmitted through steel pins to electronic IBM equipment. Turntable directs test model into wind at any angle.

5

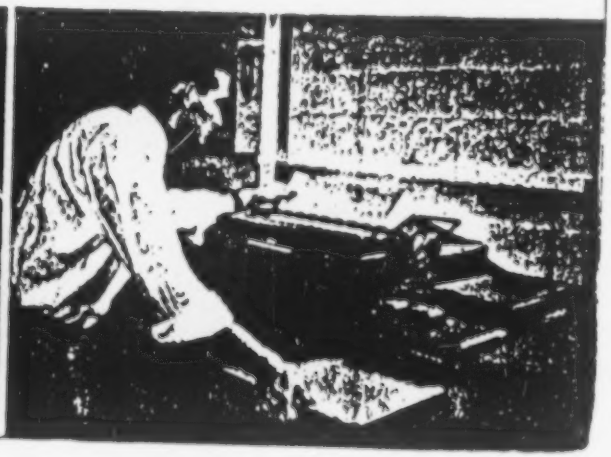
Underside of Balance Turntable shows complex equipment and delicate balance required to give engineers exact readings taken from model being tested on turntable.



Take-off Board shows information being gathered during wind tunnel test run. When model under test is set at correct angle, operator takes a test reading seen on this IBM Data Board.



IBM Data Recorder prints test result information automatically for further calculation and study by engineers.



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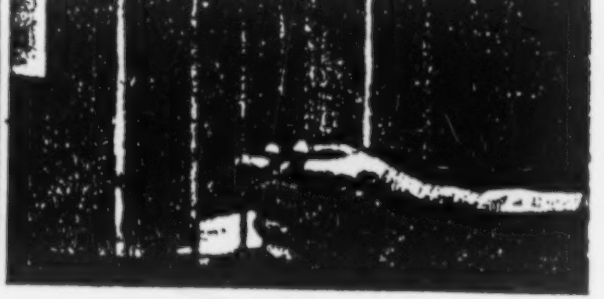
Preparing for the first test-research study

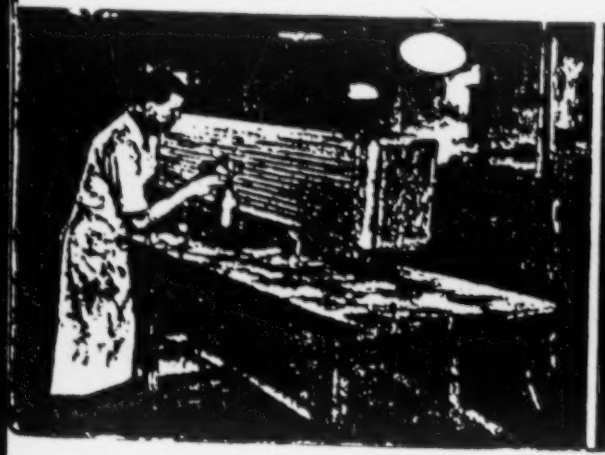
...to show the effect of wind resistance on truck-trailers. Tests conducted at the University of Maryland Wind Tunnel

Mapping out aerodynamic test-research projects to find the effect of air drag on truck-trailer designs are (left to right): J. J. Black, Vice President in charge of Engineering, Trailmobile; W. R. Hummel, Chief Engineer, Trailmobile; A. Wiley Sherwood, Professor of Aerodynamics and Manager of Wind Tunnel, University of Maryland; Paul Jung, Test Engineer, Trailmobile.



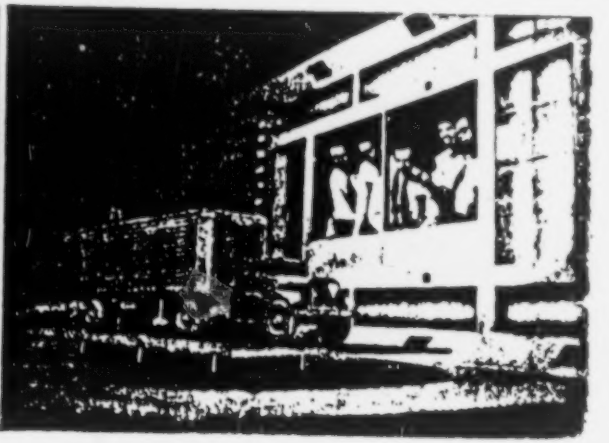
Two test side panels are carefully calibrated to meet exacting wind tunnel requirements. Wood used for top, fronts, sides and most rear end testing is imported mahogany.

Wind tunnel worker adds finishing touches to exact ¼ scale model Trailers in preparation for aerodynamic test-research. Models are made from full scale blue prints to assure accurate test readings.



Multi-tube Manometer Board gives test engineers pressure readings from as many as 100 points on the trailer model being wind-tunnel tested.

"Operation Wind Tunnel" Test Phase I, ready to begin, receives final approval from wind tunnel and Trailmobile engineers. Tractor-trailer is facing directly into wind stream at this point. Soundproof window separates wind tunnel from control room.



What is WIND?

There are two kinds of wind which affect trucking operations

The first kind of wind with which we are familiar is the kind created by nature—air moving from high pressure areas to low pressure areas. This is the wind that keeps kites in the air and turns umbrellas inside out. Believe it or not, this kind of wind has an average speed in the United States of only ten miles an hour which barely amounts to a noticeable breeze.

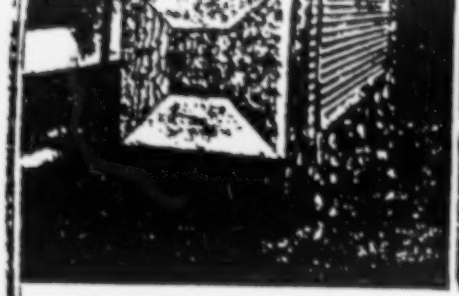
This kind of natural wind does not appreciably affect the air drag on your trucks or trailers since it might be blowing from any direction and will average out as coming from all sides over a period of time.

The second kind of wind does affect your trucks and trailers—to a very marked degree. *This is the "wind" that pushes against, or causes resistance to your vehicles as they pass through the air. At 50 mph your truck or trailer "creates its own wind," a 50-mile-an-hour wind.* This is the wind you feel when you ride in a convertible automobile.

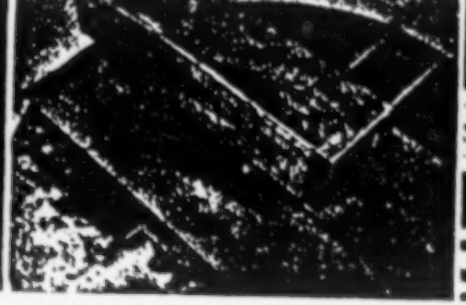
The more streamlined the vehicle, the more easily it will pass through the air. And it will require far less power to pass it through the air which means a definite savings in horsepower, gasoline, oil and friction.

The Wind Tunnel tests on the following pages prove that correct design and streamlining increases usable horsepower, decreases air drag and contributes materially to the economy of operation and the ease of handling of truck-trailers.

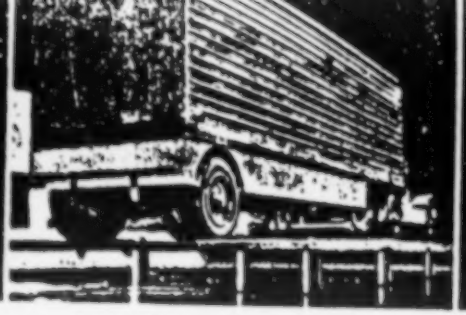
In order to make this report brief and in a form that is easy to understand we have not shown the effects of natural winds. However, these tests were made and figures are available.



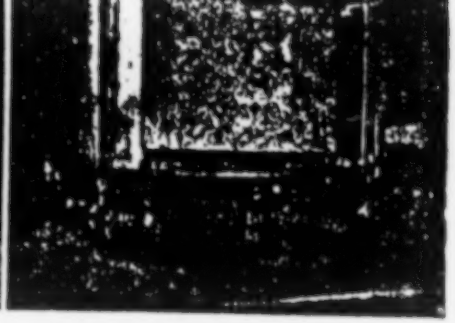
1. Rounded rear-ends, air deflecting vanes, corrugated sides.



2. Square front, vertical post (bird's eye view).



3. Drop frame with corrugated sides.



4. Square rear-end with guide vanes top and sides.

Over 7000 combinations

of design were tested in the Wind Tunnel—shown here are but a few of those test designs. No possibility was overlooked in an effort to find ways and means to reduce wind resistance of the truck-trailer unit.

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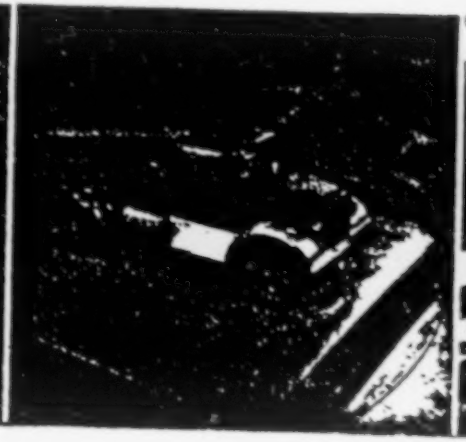
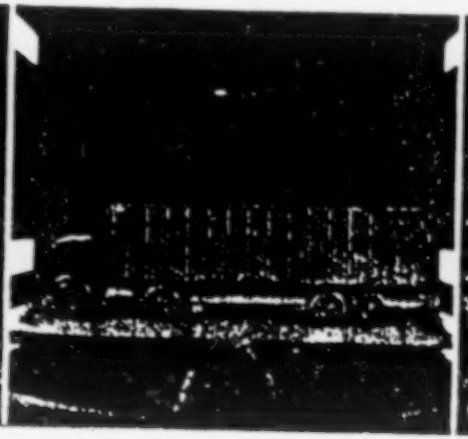
Horizontal corrugated sides with square front and COE west coast tractor.

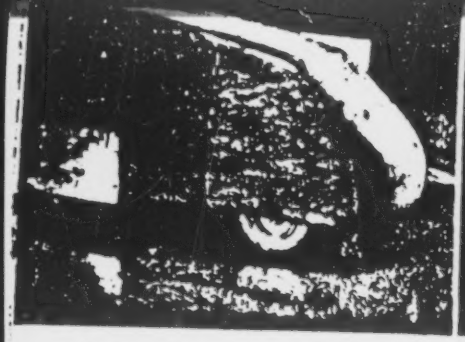


10. Conventional single axle tractor.



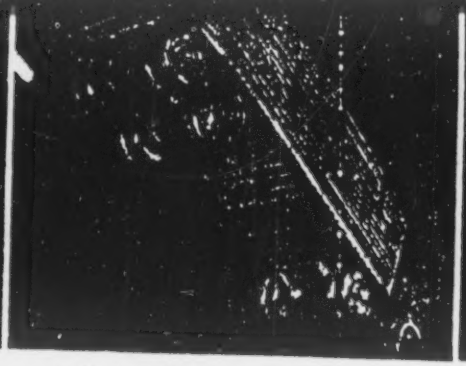
11. Vertical post sides with 6° Radius nose cap and COE tractor.

12. COE tractor with deflector under bumper, corrugated sides, skirting, and enclosed space between trailer and cab.

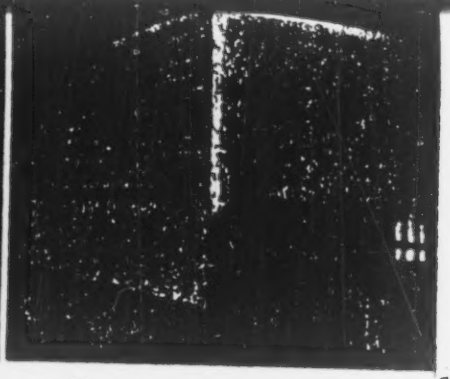


5. Tractor with rounded nose flared into trailer body.

6. Horizontal corrugated model with rounded front corners.

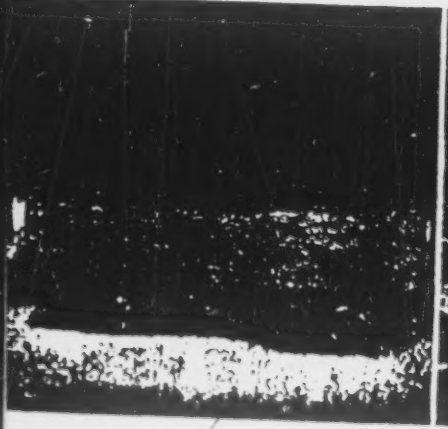


7. Horizontal corrugated sides, bolsters removed from undercarriage.

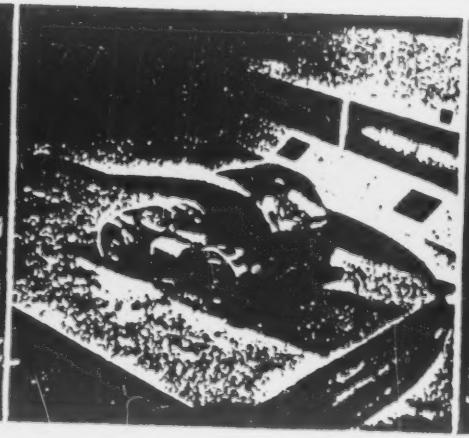


8. Horizontal corrugated sides with skirts and rounded rear-end.

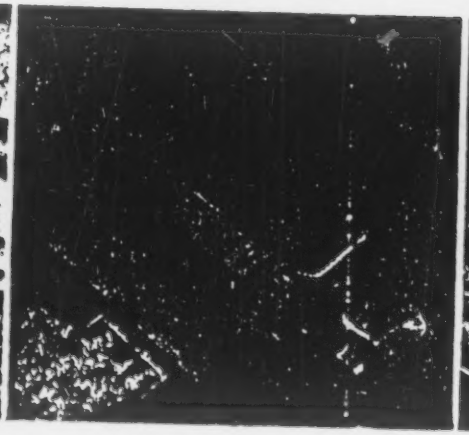
9



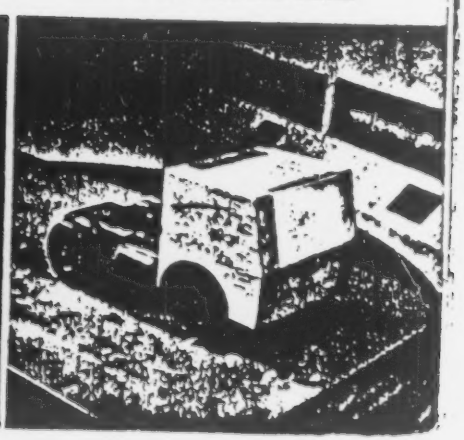
13. Smooth panel sides with rounded front end.



14. COE tractor.



15. Horizontal corrugated sides with rounded front and COE tractor.



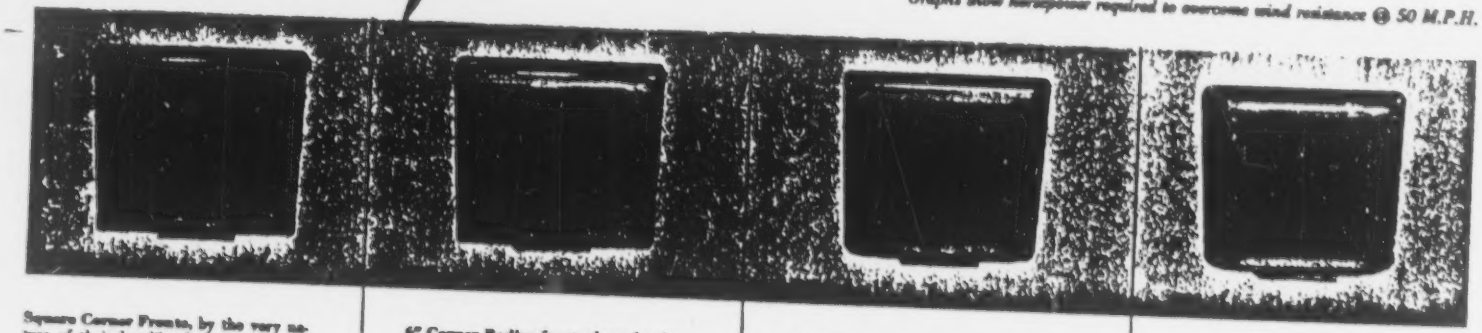
16. COE west coast tractor.

A 121

TEST PHASE NO. 85

Changing only the front corner radius of the trailer directly affects its wind resistance

Graphs show horsepower required to overcome wind resistance @ 50 M.P.H.



Square Corner Fronts, by the very nature of their box-like design, have high air drag characteristics. Aerodynamically, this front showed the most wind resistance.

54 H.P.

6" Corner Radius fronts showed a sharp reduction of 11.8% when compared to the square corner fronts.

47.6 H.P.

12" Corner Radius fronts did not show any appreciable decline in wind resistance (13.9%) over the 6" corner radius front. The 12" radius also creates certain tractor-trailer clearance problems.

46.5 H.P.

18" Corner Radius fronts showed a 14.8% reduction in wind resistance over the square front and an improvement over the 12" corner radius. The 18" corner radius also provides ample tractor-trailer clearance.

46.0 H.P.

The Wind Tunnel tests on this page show how wind resistance varies as the front corner radius is changed.

Fig. 1. The front design that shows the most wind resistance is, quite naturally, the square front as seen in Fig. 1. The square front requires 54 H.P. just to overcome wind resistance at 50 miles-per-hour.

In Fig. 2, it is evident that simply by rounding the two front corners with a 6" radius, only 47.6 H.P. is required to overcome wind resistance at 50 miles-per-hour. This is a reduction of 11.8% in horsepower requirements.

Fig. 3 proves that there is little to be gained in a 12" corner radius front over the 6" corner radius front. However when compared to a square front the difference amounts to a reduction of 13.9% in horsepower requirements to overcome wind resistance. But the 12" corner radius trailer creates certain tractor clearance problems.

Fig. 4, using an 18" front corner radius, shows the greatest reduction in wind resistance of the four front corner radius tested. The 18" corner radius front required only 46 H.P. to overcome wind resistance at 50 miles-per-hour. This is a reduction in horsepower requirements of 14.8% over the completely square front trailer. The 18" corner radius front also eliminates tractor clearance problems.

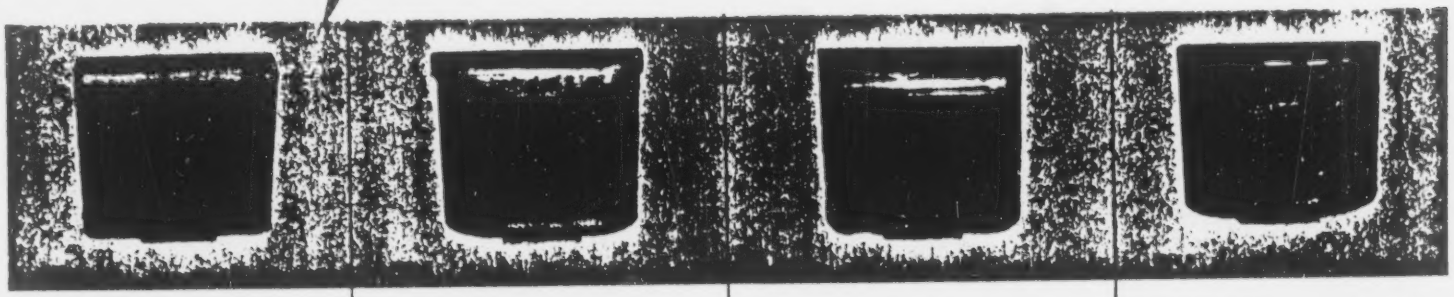
A. 122

Operation Wind Tunnel

TEST PHASE 85-A

Varying both the front corner radius and the roof radius of the trailer results in even greater differences in wind resistance

Graphs show horsepower required to overcome wind resistance @ 50 M.P.H.



6" Corner Radius front and 6" Roof Radius proved to be good since it reduced wind resistance 21.1% over the square front yet maintained full inside front loading advantages.

42.6 H.P.

18" Corner Radius fronts with 6" Roof Radius was one of best fronts tested. This front showed a remarkable 23.5% drop in wind resistance.

41.3 H.P.

18" Corner Radius fronts with 18" Roof Radius showed no reduction in wind resistance over the 18" corner radius front with 6" roof radius.

41.3 H.P.

The Oval Front proved to have the least wind resistance of all front designs tested—28.5%. However the oval front reduces the inside cubic capacity of the trailer and tends to offset the savings from streamlining.

38.6 H.P.

The Wind Tunnel tests on this page show to what degree wind resistance changes as both corner and roof radius are varied.

Fig. 5, with a 6" corner radius front and a 6" roof radius results in a 21.1% reduction in wind resistance when compared to the square front end trailer. Only 42.6 H.P. are required to overcome wind resistance with the 6" corner and 6" roof radius combination, as against 54 H.P. for a square front trailer.

Fig. 6 shows what happens when an 18" front corner radius trailer is used in combination with a 6" roof radius. Here, only 41.3 H.P. is required to overcome wind resistance as against 54 H.P. for a square front trailer. This amounts to a 23.5% reduction in wind resistance.

Fig. 7 is the same as Fig. 6 except the roof radius was increased from 6" to 18". This did not result in a reduction in wind resistance or a decrease in horsepower requirements over the 18" front corner radius and 6" roof radius as shown in Fig. 6.

The oval front, **Fig. 8**, proved to have the least wind resistance of all fronts tested in the Wind Tunnel. It showed that only 38.6 H.P. was required to overcome wind resistance—a reduction of 28.5% in horsepower requirements over the square corner front. However the oval front sacrifices an excessive amount of inside cubic capacity, which in the long run could result in losses of revenue which would far outweigh its benefits in decreased wind resistance. This is a prime example of how the point of diminishing return operates.

What this means to you as an operator . . . Using a regular square-front trailer as the basis for comparison it requires 54.0 horsepower at 50 mph to overcome "air drag" or wind resistance.

Using the 18" radius corner

@ 40 mph air drag reduction saves 5.12 h.p.
@ 50 mph air drag reduction saves 8.0 h.p. } or 14.8%
@ 60 mph air drag reduction saves 11.5 h.p.

Using the 6" radius —corner and roof

@ 40 mph air drag reduction saves 7.3 h.p.
@ 50 mph air drag reduction saves 11.4 h.p. } or 21.1%
@ 60 mph air drag reduction saves 16.4 h.p.

Using the 18" radius corner with 6" roof radius

@ 40 mph air drag reduction saves 8.1 h.p.
@ 50 mph air drag reduction saves 12.7 h.p. } or 23.5%
@ 60 mph air drag reduction saves 18.3 h.p.

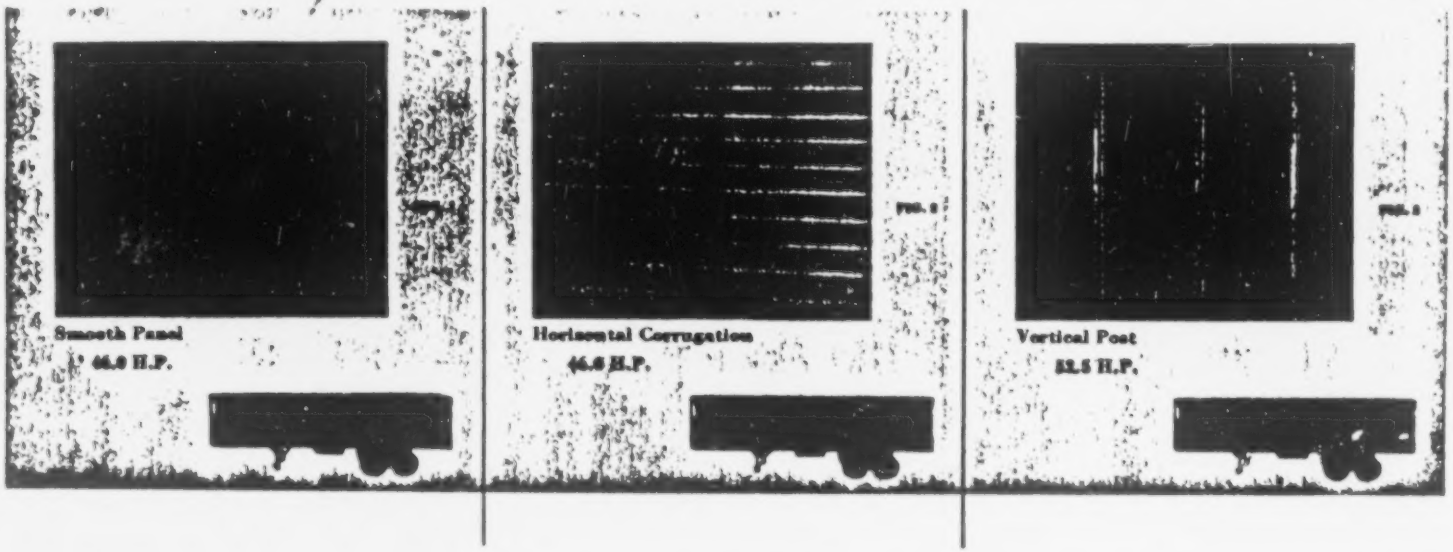
A 123

Operation Wind Tunnel

TEST PHASE 98

Wind resistance is increased or decreased, depending on the design of the trailer side

Figures show horsepower required to overcome wind resistance @ 50 M.P.H.



As many truck operators have long contended, the type of trailer side plays a large part in decreasing or increasing wind resistance. On certain hauls this can affect gasoline and oil consumption, engine wear and horsepower requirements and ease of handling of the tractor-trailer unit.

Fig. 1 & 2: The smooth panel trailer side (Fig. 1), and the horisontal panel side (Fig. 2), when tested in the Wind Tunnel show that only 46 H.P. are required to overcome wind resistance at 50 miles-per-hour.

Fig. 3: The vertical post design trailer (Fig. 3), results in a higher degree of wind resistance, according to Wind Tunnel tests. This type of side requires 52.5 H.P. to overcome wind resistance at 50 miles-per-hour. This is an increase of 14.1% over the smooth side design trailer.

A 124

Operation Wind Tunnel

TEST PHASE 98-A

Average fuel savings for various trailer front and side combinations.

(Cross-reference of side and front design and their effect on horsepower requirements are based on 50 m.p.h. truck speeds)

Listed on the chart at right are various combinations of side designs as related to front designs. In each case the H.P. figure represents the horsepower drag of wind resistance at 50 mph. The dollar figures shown represent the estimated annual savings in fuel costs of these combinations as compared to a vertical post trailer with a square front (as indicated by "Base").*

These figures may also be used to estimate annual savings of other combinations. For example, to compare a trailer with a square front smooth panel side versus a trailer with 18" corner radius front and smooth panel side:

$270.00 (18" radius front, smooth side panel)

—95.00 (square front, smooth panel side)

$175.00 approximate annual savings

*These figures are based on the following:

Annual mileage 60,000 miles
fuel consumption 4 miles per gallon
fuel cost $0.24 per gallon
54,000# gross vehicle weight
average speed 50 mph

Special Note: The above figures are based on averages. The conclusions are one way of several, to evaluate horsepower savings. Computations were derived from figures obtained in the 1954 S.A.E. Handbook "Truck Ability Prediction Procedure" and Wind Tunnel Test data.

For specific savings that you can expect in your operation, fill in all details on the attached reply card.

	Vertical Post	Smooth Panel	Horizontal Corrugated
Square Front	53.3 H.P. Estimated Annual Fuel Savings BASE	54.0 H.P. Estimated Annual Fuel Savings $95.00	54.0 H.P. Estimated Annual Fuel Savings $95.00
6" Radius Corners 6" Radius Roof	49.8 H.P. Estimated Annual Fuel Savings $190.00	42.6 H.P. Estimated Annual Fuel Savings $345.00	42.6 H.P. Estimated Annual Fuel Savings $345.00
18" Radius Corners	53.5 H.P. Estimated Annual Fuel Savings $130.00	46.0 H.P. Estimated Annual Fuel Savings $270.00	46.0 H.P. Estimated Annual Fuel Savings $270.00
18" Radius Corners 6" Radius Roof	49.2 H.P. Estimated Annual Fuel Savings $200.00	41.3 H.P. Estimated Annual Fuel Savings $375.00	41.3 H.P. Estimated Annual Fuel Savings $375.00

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Ideas and design changes show attempts to decrease trailer wind resistance

On these pages are design attempts to find new ways to reduce wind resistance. The color bar and the part of each trailer model shown in green is that part where design changes have been made.

In each case, design changes were measured and compared to a trailer with smooth sides, an 18" corner radius front and 6" radius roof, connected to a tractor of conventional design moving at a speed comparable to 50 miles-per-hour.

With Cab To Body Space Filled was found the largest single contribution to drag reduction. Although impractical at this time, serious study is being given this important area for future development.

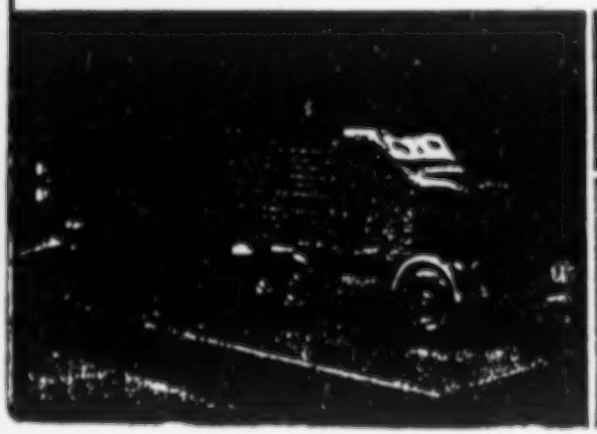
[redacted]

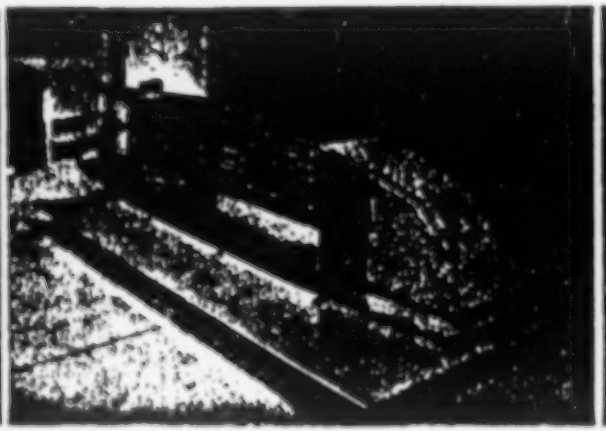
Fully Streamlined Tractor-Trailer—this combination approaches the ideal aerodynamic tractor-trailer design. Drag of this unit is only about 1/5 of that obtained with conventional tractor-trailer combinations, but existing state laws make this near-ideal combination impractical for now.

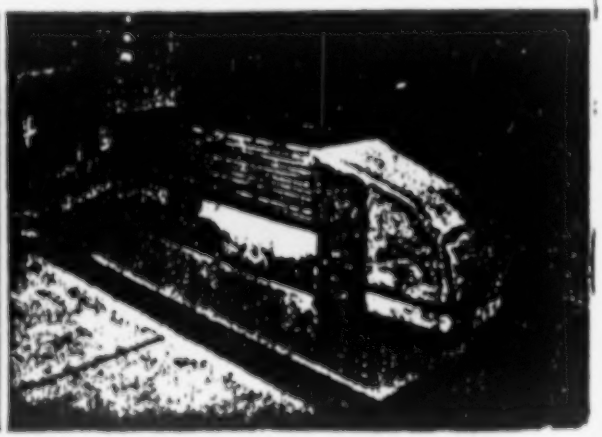
[redacted] Combination 8.1 H.P.

Streamlined Combination Without Boattail—this streamlined combination allowed a smooth flow of air along the tractor and trailer side and top surfaces and resulted in a drag reduction of 63%. This combination may prove practical in modified form in the near future.

Conventional Combination [redacted] tion 15.2 H.P.







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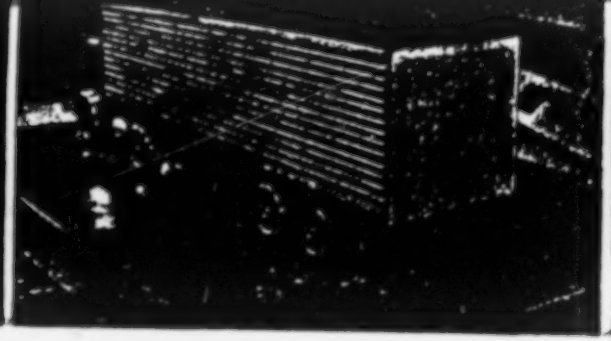
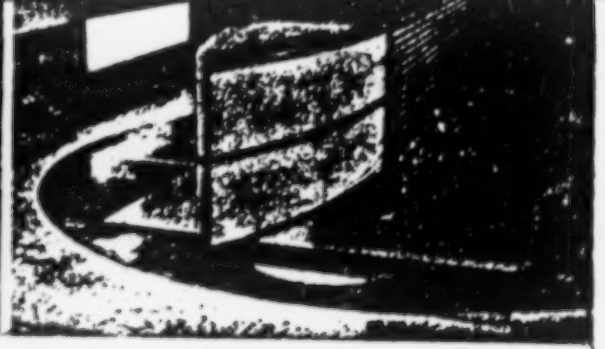




Cobble Vanes—the test use of guide vanes was an unsuccessful effort to obtain a drastic reduction in air drag. Based on previous European tests these were expected to deflect the air in such a manner as to cause a reduction in air drag on the trailer. However, tests proved negative.

[redacted]

Rounded Rear Corners—are not effective in reducing drag since the so-called "vacuum" at the rear of the trailer was insignificant.

[redacted]

"Beaver Tail"—the application of a "Beaver Tail" to a trailer reduces the drag by 12%, but the extra length of this combination cargo space makes it impractical for present day use.

[redacted]

This Semi-Streamlined combination provided a 37% drag reduction. At this time it is impractical to enclose the spacing between tractor cab and trailer, but it may open possibilities for future design improvements.

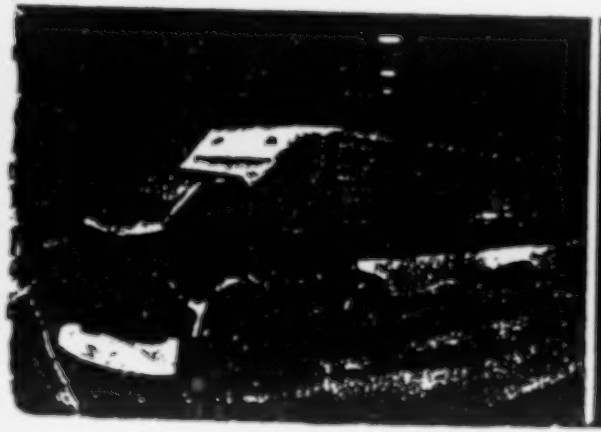
[redacted] H.P.

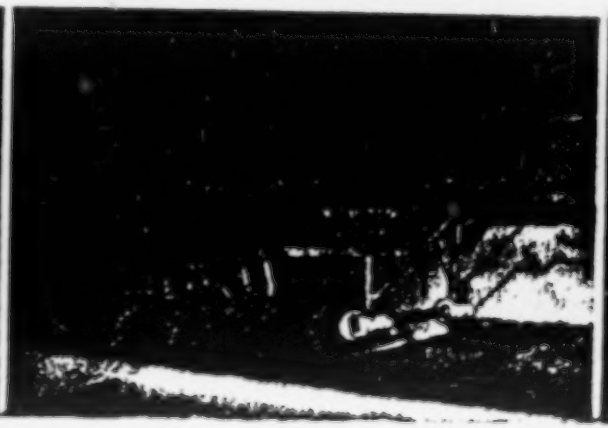
The Flap mounted at the rear of the tractor frame blanked the flow of air beneath the trailer and created an additional 2.3% drag instead of an anticipated air drag reduction.

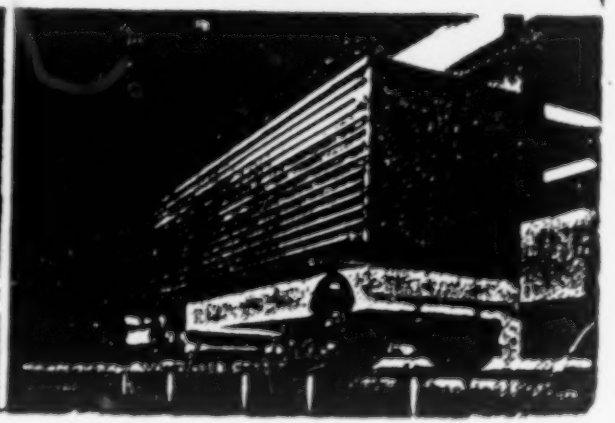
[redacted]

Adding A Drop To The Trailer created a 2.9% increase in the drag. This indicates that wind resistance problems of the drop frame trailer are basically the same as the straight frame.

[redacted]







An important conclusion . . . .

of interest to all members of the trucking industry

For several decades the question of wind resistance and air drag versus the streamlining of truck-trailers has been the subject of wide discussion in the trucking industry. Trailmobile, in cooperation with the American Trucking Associations Foundation, Inc., decided to find out once and for all just what the facts were. "Operation Wind Tunnel" is the result.

Some of the most important findings are published in this booklet. They are offered to the trucking industry as a service to further understanding and to result in a more economical trucking operation.

Wind Tunnel data indicate the drastic streamlining of front-ends to be highly desirable, but impractical under today's legal length restrictions. It was found that the correct front-end design on a trailer can save users as much as 23.5% in horsepower requirements to pull through the air, as against a trailer with a square front-end.

These savings when added together over the months and years are too important to be overlooked. They can materially reduce current high operating costs. New design advances resulting from these tests mean even easier handling and smoother pulling of the trailer unit on the highway.

Certain trailer side designs when used in conjunction with rounded front ends also result in easier handling and economy of operation.

The continuing trend toward demand for increased cubic capacity means that trailer manufacturers must provide both—outside streamlining and more usable inside freight space. Neither factor by itself is a satisfactory answer. The trailer of the future, the near future, must have maximum cubic capacity and maximum practical streamlining in design to give the trucking industry the economy of operation it requires to go forward.

This booklet is published by Trailmobile Inc., in conjunction with the American Trucking Associations Foundation, Inc., as a joint test-research project on behalf of the Trucking Industry. Address all inquiries to Trailmobile Inc., Cincinnati 9, Ohio. Attention: Wind Tunnel Data Department.

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APPENDIX N

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District Court Trial Exhibits

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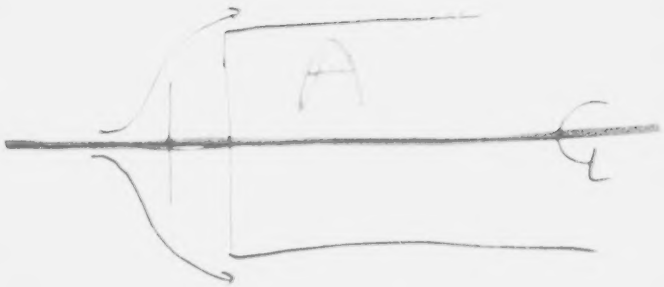
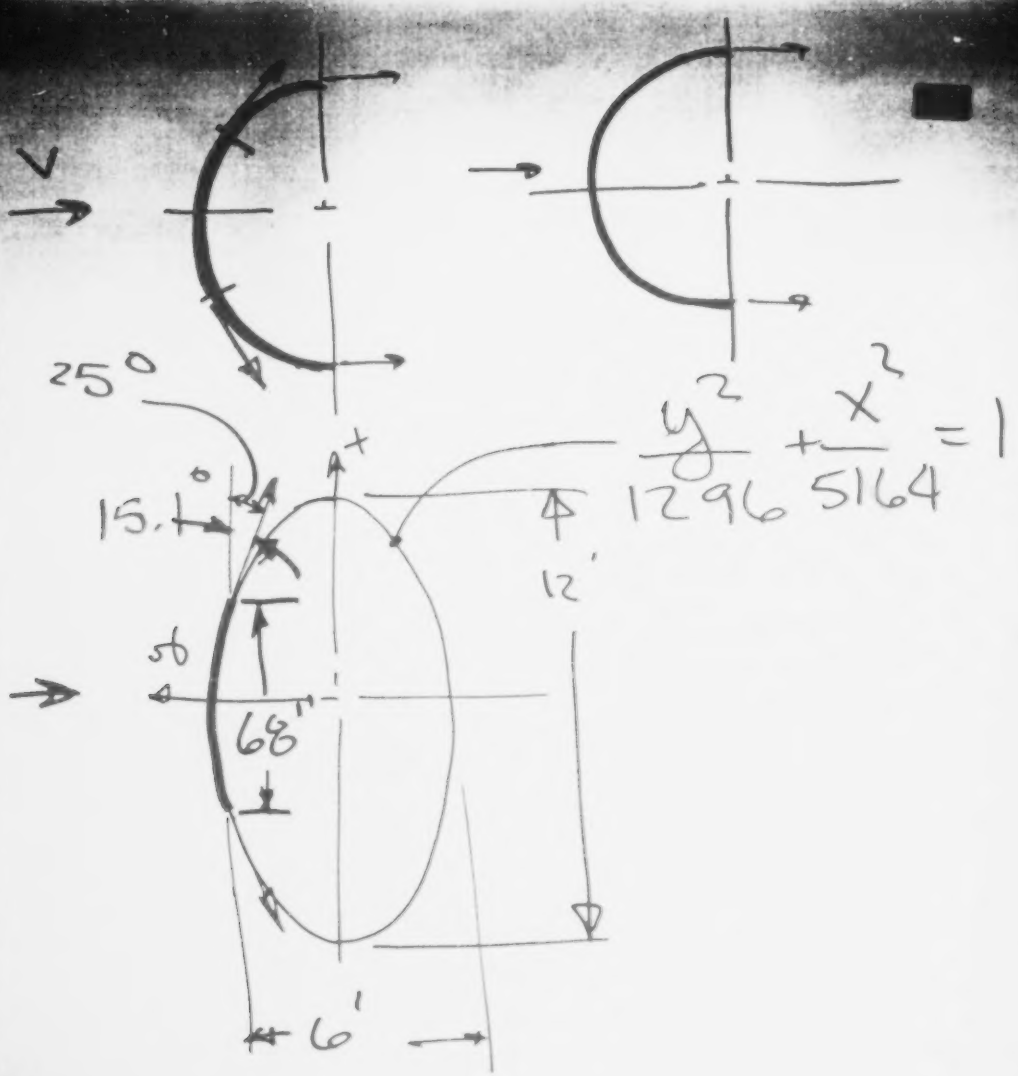


Plaintiff's Exhibit No. 419
Case No. N75-51
Date 11-26-82



Defendant's Exhibit No. 50
File No. N75-51
Date 11-15-82

(3)

No. 87-2046

Supreme Court, U.S.
FILED
JUL 8 1988
JOSEPH F. SPANIOL, JR.
CLERK

IN THE

Supreme Court of the United States

OCTOBER TERM, 1987

UNIROYAL, INC.,

Petitioner,

—v.—

RUDKIN-WILEY CORPORATION,

Respondent.

PREMIX, INC.,

Petitioner,

—v.—

RUDKIN-WILEY CORPORATION,

Respondent.

RESPONDENT'S ANSWER TO PETITIONERS' PETITION FOR A WRIT OF CERTIORARI TO THE UNITED STATES COURT OF APPEALS FOR THE FEDERAL CIRCUIT

Francis T. Carr
Albert J. Breneisen
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Attorneys for Respondent

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—v.—

RUDKIN-WILEY CORPORATION,

Respondent.

PREMIX, INC.,

Petitioner,

—v.—

RUDKIN-WILEY CORPORATION,

Respondent.

RESPONDENT'S ANSWER TO PETITIONERS' PETITION FOR A WRIT OF CERTIORARI TO THE UNITED STATES COURT OF APPEALS FOR THE FEDERAL CIRCUIT

STATEMENT OF THE CASE

A young inventor named Selden Saunders working in 1962 alone in his father's garage invented an air-deflecting device for reducing wind resistance encountered by tractor-trailer vehicles. This device is now a common sight on the nation's highways. Saunders' invention, a baffle or deflector mounted on the cab roof of a tractor and sized and positioned according to the size

of the tractor and trailer, reduces the wind resistance encountered by a tractor-trailer combination to provide substantial fuel savings of about 5%, without redesigning the tractor or the trailer. Saunders' invention generated a multi-million dollar industry and has saved hundreds of millions of gallons of fuel in this country alone.

In 1966, appellant Rudkin-Wiley, a small entrepreneurial company looking to market an innovative product, recognized the enormous commercial promise of Saunders' invention and, respecting and relying upon the U.S. patent laws, agreed to pay royalties under an exclusive license. Petitioner Uniroyal also came to recognize the enormous commercial promise of Saunders' invention, although some seven years later. Uniroyal surreptitiously purchased a licensed Rudkin-Wiley air deflector, which it considered to be a "novel thing," copied it and added two features (adjustability and vertical curvature). After failing in its attempts to obtain a license from Saunders or Rudkin-Wiley, Uniroyal filed its declaratory judgment action. Meanwhile, Uniroyal, along with its successor, Petitioner Premix, has sold tens of thousands of their look-alike deflectors.

ARGUMENT

Respondent Rudkin-Wiley Corporation respectfully submits that Petitioners', Uniroyal, Inc. and Premix, Inc., petition for a writ of certiorari should be denied.

The United States Court of Appeals for the Federal Circuit vacated and reversed the judgment by the United States District Court for the District of Connecticut holding U.S. Patent 3,241,876 ('876 patent or Saunders' patent) invalid and noninfringed. The decision of the Federal Circuit is in accord with a prior decision of the United States Court of Appeals for the Seventh Circuit which in 1981 found the Saunders '876 patent to be valid. *Saunders* v. *Air-Flo Co.*, 646 F.2d 1201 (7th Cir. 1981).

Petitioners' application for certiorari mischaracterizes and ignores the gravamen of the Federal Circuit's decision, and fails

to raise any issue deserving this Court's consideration. Petitioners' contention that the district court's judgment was improperly overturned after a selective review of the available record overlooks the adequacy and comprehensiveness of the record on appeal.

In accord with the standards of appellate review set forth at length in *Panduit Corp.* v. *Dennison Mfg. Co.*, 810 F.2d 1561, 1566 (Fed. Cir. 1987), *cert. denied*, ____ U.S. ____, 107 S. Ct. 2187 (1987) the Federal Circuit reversed the district court's holdings of invalidity and noninfringement. As in *Panduit*, 810 F.2d at 1565, the Federal Circuit held that the district court erroneously found the patent invalid by making several errors of law. In the district court's analysis of validity, the Federal Circuit explicitly identified multiple errors of law namely, the district court:

1. impermissibly used hindsight to reconstruct the claimed invention from prior art;
2. erroneously analyzed the secondary considerations of nonobviousness;
3. disregarded undisputed differences between the claimed invention and the prior art because the invention and the prior art relied upon the same scientific principles; and
4. apparently used the often rejected "obvious to try" standard of patentability.

Moreover, upon the Federal Circuit's review of the district court's analysis of infringement, additional errors of law were identified, by way of example:

1. failure to construe the claims in view of the specifications;
2. reading a limitation from claim 1 of the '876 patent into independent claim 2;
3. reliance upon Uniroyal's improvement patent as negating infringement; and

4. declined to consider certain height and position limitations in the claims as literally satisfied, despite a finding that the Uniroyal air shield met these limitations, because Uniroyal's engineers used different formulae to arrive at those heights and positions than the '876 patent formulae.

These and other equally serious legal errors, not erroneous fact findings, compelled reversal or remand of the district court's decision. As such, the Federal Circuit's decision follows *Panduit* and the Supreme Court precedent cited therein. *See* 810 F.2d at 1569 ("our earlier opinion having noted that reversal was required by legal error and the district court's correct and controlling findings . . . , explicit reference to Rule 52(a) was not made.") (footnote omitted).

Notwithstanding the erroneous statement of law by the district court, the Federal Circuit, as in *Panduit*, 810 F.2d at 1565, examined and relied upon the district court's findings of fact to mandate the Federal Circuit's holdings. Contrary to Petitioners' contention, the Federal Circuit reviewed the relevant record which was before the district court, specifically considering a part of the available record namely, the Joint Appendix—a jointly compiled reproduction of the evidence pertinent to the issues appealed. Approximately 2,583 pages including approximately 121 trial exhibits and 1,243 pages of testimony from nine witnesses was presented in the Joint Appendix. Petitioners, prior to the Federal Circuit's judgment, never indicated that anything material was omitted from the Appendix or misstated or otherwise not previously identified as worthy of the particular attention of the court. Moreover, Petitioners have not identified any evidence of record not in the Joint Appendix which in any way is contrary to the Federal Circuit's decision. Petitioners should not now be heard to complain of an inadequate record included in the Joint Appendix which they participated in compiling. *See Mandel* v. *Max-France, Inc.*, 704 F.2d 1205, 1207 (11th Cir. 1983); *Bullen* v. *De Bretteville*, 239 F.2d 824, 836 (9th Cir. 1956), *cert. denied*, 343 U.S. 947 (1957).

Petitioners' claim that the Federal Circuit's review of the evidence is contrary to recognized appellate procedure is not supported by Petitioners' cases.

Icicle Seafoods, Inc. v. *Worthington*, 475 U.S. 709 (1986) involved a Court of Appeals decision in which "nowhere in its opinion did the court ever mention any of the factual findings of the District Court, much less discuss or analyze them." *Id.* at 713. Instead, the Court of Appeals conducted a *de novo* review of the record to determine the factual "question of how the respondents spent their working time on board the [ship they worked on]." *Id.* at 714. By contrast, the Federal Circuit herein carefully analyzed the district court's factual findings and made no contrary factual findings of its own.

Likewise, in *Anderson* v. *City of Bessemer City, North Carolina*, 470 U.S. 564 (1985) "the Fourth Circuit improperly conducted what amounted to a *de novo* weighing of the evidence in the record." *Id.* at 576. At issue were not errors of law and mixed questions of law and fact, but pure questions of fact, e.g., which of two people was more qualified for a particular position, on which the Court of Appeals improperly substituted its independent judgment for that of the trier of fact. By contrast, the Federal Circuit in the case at bar relied entirely upon the findings of the district court.

Indeed, the Federal Circuit did recognize its appellate limitations remanding for factual determinations and analysis the issue of infringement under the equitable doctrine of equivalents.

CONCLUSION

It is respectfully submitted that Petitioners writ of certiorari should be denied.

Respectfully submitted,

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No. 87-2046

IN THE

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PETITIONERS' REPLY BRIEF TO RESPONDENT'S BRIEF IN OPPOSITION TO PETITION FOR WRIT OF CERTIORARI TO THE UNITED STATES COURT OF APPEALS FOR THE FEDERAL CIRCUIT

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RUDKIN-WILEY'S STATEMENT OF THE CASE

Respondent Rudkin-Wiley's brief[1] in opposition to Uniroyal/Premix's petition for a writ of certiorari states as fact, without reference to any supporting findings, matters on which the district court made contrary factual findings. For example, despite Rudkin-Wiley's assertion that Uniroyal "copied" Rudkin-

1 Hereinafter cited as "R-W br.".

Wiley's deflector (R-W br. at 2), the district court specifically concluded, upon all of the pertinent facts set forth in the opinion[2], that "Rudkin-Wiley's copying claim is . . . without merit." (Appendix B at 54a). Other such factual errors are also present in Rudkin-Wiley's statement of the case; but specific comment on such misstatements would digress from the appropriate focus of this reply.

REBUTTAL ARGUMENT

I. THE FEDERAL CIRCUIT'S REVERSAL OF THE JUDGMENT INVOLVED FACTUAL, NOT MERELY LEGAL QUESTIONS

What is most significant about Rudkin-Wiley's response is that it does not—because it cannot—refute the fact that the Federal Circuit arrived at its decision reversing the judgment of invalidity based upon obviousness without having reviewed the entire record. Rudkin-Wiley's suggestion that the Federal Circuit's decision involved merely a determination that there were "errors of law", not clearly erroneous findings of fact, is fundamentally inconsistent with the substance of that decision. In the absence of district court findings necessary to a resolution of the obviousness question, a court of appeals would vacate the judgment in the presence of errors of law and remand for necessary findings. *Icicle Seafoods, Inc.* v. *Worthington*, 475 U.S. 709, 714 (1986); *Panduit Corp.* v. *Dennison Manufacturing Co.*, 810 F.2d 1561, 1565 (Fed. Cir.), *cert. denied*, ____

2 This included, *inter alia*, findings that when the inventor of the Uniroyal device studied an early Rudkin-Wiley deflector, he concluded that it was a flat plate, high drag device designed to deflect the air almost perpendicular to the cab's centerline; that the '876 patent describes such a high drag device; that Uniroyal's inventor set out to, and did, develop a streamlined, low drag device shaped somewhat like a hemispheric shell with a smooth, curved forebody; that, much like a fairing, the Uniroyal device was designed to allow the flow to leave the trailing edge of the device smoothly and without abrupt change of direction; and that the Uniroyal deflector operates on different aerodynamic principles from the device of the '876 patent. (Appendix B at 49a, including note 5.)

U.S. ____, 107 S.Ct. 2187 (1987). Only where a proper application of the law by the court of appeals to unassailable findings by the district court compels reversal (a situation not present here as discussed at pages 4-5, *infra*), or where the "findings on which the obviousness conclusion rested are clearly erroneous and . . . nothing *of record* warrants a further exercise of the fact-finding function or indicates any possibility that the appealed judgment might be sustained by such exercise" is reversal of the judgment appropriate. *Panduit* v. *Dennison*, 810 F.2d at 1565-6 (emphasis added); see also *Icicle Seafoods* v. *Worthington*, 475 U.S. at 714.

At the heart of the Federal Circuit's decision on validity was its conclusion that the district court had failed to view the invention "from the position of a person of ordinary skill at the time it was made" (837 F.2d at 1051; Appendix A at 8a) and that there had been "no apparent basis for the district court's conclusion that it would have been obvious to one skilled in the art to make the combination." (837 F.2d at 1052; Appendix A at 11a). The level of ordinary skill in the pertinent art at the time the invention was made is one of the necessary underlying *factual* inquiries which the trier of fact must make en route to a determination of obviousness. *Graham* v. *John Deere Co.*, 383 U.S. 1, 17 (1966). The district court made this inquiry and found, as a fact, that the level of ordinary skill in the art would be that of an engineer familiar with aerodynamic or fluid mechanic principles. (Appendix B at 39a). After considering extensive expert evidence in the form of testimony, sketches, videotapes of airflow tests and in-court demonstrations relating to such principles, the district court further found that the prior art references taken collectively would have suggested the combination to such an engineer presumed to be familiar with such references. See *In re Conrad*, 439 F.2d 201, 205 (CCPA 1971). (Appendix B at 41a-43a).

The described principles of aerodynamics and fluid mechanics involve questions of fact, not law. Absent a review of the full evidence which had been before the district court concerning these fundamental principles, it was impossible for the Federal Circuit to know with what underlying technical under-

standing of the relevant principles an engineer possessing such ordinary skill would have assessed the prior art references. That it may not be obvious to a person untutored in music that certain combinations of tones will produce harmony (and others dissonance) in a musical composition, for example, does not mean that such matters will be non-obvious to a musician of ordinary skill.

In the present case, how was it possible for the Federal Circuit to reject the district court's conclusion that the combination of prior art references would have been obvious to a person of ordinary skill at the time of the invention without an understanding (based on review of the same evidence the district court had carefully considered) as to the perspective—in terms of underlying knowledge—from which a person so skilled would view the prior art? Similarly, how was it possible for the Federal Circuit to conclude that the district court had "erroneously analyzed and weighed secondary considerations of non-obviousness" (837 F.2d at 1501; Appendix A at 8a) without reviewing *all* of the evidence on such questions that had been before the district court? How too, without review of the entire record, could it be determined that nothing else "of record" would warrant a further exercise of the fact-finding function or would indicate any possibility that the appealed judgment might be sustained by such exercise?

II. THE FEDERAL CIRCUIT MADE ITS OWN FACTUAL FINDINGS IN CONFLICT WITH THE DISTRICT COURT FINDINGS

Rudkin-Wiley has attempted to avoid the necessity of admitting that the Federal Circuit's decision is necessarily based upon declaring district court findings "clearly erroneous" by urging that the Federal Circuit made no factual findings of its own but relied entirely on the findings of the district court. (R-W br. at 4-5) But this argument conflicts directly with the unequivocal words and actions of the Federal Circuit. Without repeating in full the discussion set forth in Uniroyal/Premix's petition, Rudkin-Wiley's argument can be refuted by reference simply to the Federal Circuit's ruling concerning secondary consider-

ations. The district court, *on all of the evidence*, found (a) that there was no evidence of a long-felt need for the Saunders device (Appendix B at 39a-40a); (b) that the features of the Saunders device did not carry with them a new and unexpected result (*Id.* at 42a); and, in substance, (c) that all of the circumstances were such as *not* to establish that many skilled people had addressed the problem over time without finding the solution (*Id.* at 40a). In direct contradiction of these factual findings, the Federal Circuit, on the basis of no more than the *partial evidence* printed in the appellate appendix, found (a) that the district court overlooked the fact that it was the claimed invention to which the industry turned after the 1973 oil crisis; (b) that it was the uniqueness of the claimed invention which made this so (837 F.2d at 1053; Appendix A, at 13a); and (c) that the district court "did not take into account other objective evidence of long-felt need and the failure of others" (837 F.2d 1054; Appendix A at 13a), including the Maryland study.

On the basis of its own findings on a *partial* record which were contrary to those of the district court on the *complete* record, the Federal Circuit stated that "we are convinced that the secondary evidence *as a whole* strongly suggests the nonobviousness of the claimed invention." (837 F.2d at 1054; Appendix A, at 14a; emphasis added.) It is difficult to imagine issues much more factual in their nature or appellate findings much more clearly in conflict with district court factual findings. As discussed in detail in Uniroyal/Premix's petition for certiorari, other findings of the Federal Circuit are also in direct conflict with the factual findings of the district court.[3] Beyond question, even a cursory reading of the Federal Circuit's opinion refutes Rudkin-Wiley's claim that it is based entirely upon the *district court's* factual findings and not on contrary factual findings by the Federal Circuit.

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3 See Uniroyal/Premix Petition for Writ of Certiorari, pps. 20-25, 28-29.

III. RUDKIN-WILEY ARGUES FOR AN INCORRECT INTERPRETATION OF THE APPELLATE RULES

Nothing in Rudkin-Wiley's brief in opposition to the petition suggests that the Federal Circuit reviewed the complete evidence on these questions or others. To the contrary, Rudkin-Wiley's brief acknowledges the fact that the Federal Circuit considered, at most, only "part of the available record" on such matters. (R-W br. at 4)

Implicit in Rudkin-Wiley's argument is the concept that the Federal Rules of Appellate Procedure do not mean what they say; and that, in conflict with the long-standing principle that it is the burden of the appellant to show error, a court of appeals can instead impose upon an appellee the burden of establishing an absence of error by requiring him to include within an appendix *all* evidence which supports each essential finding of the district court. On Rudkin-Wiley's theory, an appellate court can conclude that factual findings are clearly erroneous simply on the basis of a review of the *partial* record reproduced in the appendix.

Such has never heretofore been the rule. Nor do the cases cited by Rudkin-Wiley in any way support Rudkin-Wiley's position. *Mandel* v. *Max-France, Inc.*, 704 F.2d 1205 (11th Cir. 1983), involved an appellate circumstance in which the judgment had to be reversed unless it could be "affirmatively established that there was no prejudice *on viewing the entire record*." 704 F.2d at 1206 (emphasis added). Because appellee had failed to cause inclusion *in the record* of parts of the transcript needed to show the error harmless, a new trial was mandated. *Id.* at 1207. In the same vein, appellees in *Bullen* v. *De Bretteville*, 239 F.2d 824, 835-6 (9th Cir. 1956), *cert. denied*, 353 U.S. 947 (1957), were forced to bear the consequences of an inadequate *record* on appeal by reason of their failure to utilize procedures available to supplement it. Neither case equated the record on appeal to the appellate appendix or penalized an appellee for failure to include necessary parts of the record in the appellate appendix.

In the present case the *record* on appeal to the Federal Circuit was complete. What was incontrovertibly lacking was the appellate review of that record in its entirety that is a prerequisite to reversal of both the findings and judgment of the district court on the grounds here asserted by the Federal Circuit.

CONCLUSION

For all of the reasons set forth in Uniroyal/Premix's petition for a writ of certiorari, that petition should be granted.

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